LAND EVALUATION FOR RURAL PURPOSES

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SUMMARY OF AN EXPERT CONSULTATION

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C O N T E N T S

INTRODUCTION

Since time immemorial, man has evaluated land for his own, mainly rural, purposes. He placed his houses on high parts of levees in river plains, planted his wheat on well-drained land or his rice where it would be inundated at the proper time.

The last hundred years have seen an ever-accelerating accumulation of data on the suitability of land for different rural purposes - but not necessarily in a form available to, and digestible by, present and potential users of land or planners and decision-makers.

Within the last fifty years, various systems of evaluating soil or land suitability have been initiated. Germany devised a numerical (parametric) system for ranking the value of land for agriculture. A system developed in the USA classifies general suitability for agriculture, uniform over half a continent but limited to soil suitability. Another American system, which includes some non-soil land factors like the availability and cost of water, is only applicable to individual irrigation projects. These, and other systems in other countries, are restricted to single uses, broadly or more narrowly defined.

Over the last ten years, a movement has been obvious in the direction of parallel classifications for different uses, which enable sound planning decisions to be made where possible uses are competing with one another for the same land. Canada is at the forefront of this movement, with its effective computer-based system.

By now most countries in the world have established their own particular systems of land evaluation, making it difficult for data and experience gained in one country to be transferred to another, even where conditions are similar.

Clearly there was a need for an international exchange of ideas and information on the subject of land evaluation for rural purposes, and there was general agreement on the need for international standards. These needs could best be served, it was thought, by an international expert consultation on the subject, to be convened after adequate preparation. Conceived in 1970, the idea of such a consultation was to develop a framework of land evaluation that would be widely acceptable to survey and evaluation organizations and would meet the needs of the widest range of possible users.

Preparatory work for the consultation was undertaken by two multidsciplinary committees: one in The Netherlands, the other within FAO. A document, jointly prepared by these two committees, was to provide the background for discussions at the consultation.

The Consultation on Land Evaluation for Rural Purposes took place from 6-12 October 1972. It was convened by the Food and Agriculture Organization of the United Nations in cooperation with the University of Agriculture and the International Institute for Land Reclamation and Improvement, Wageningen, and was held at the International Agricultural Centre, Wageningen.

This report presents a summary of the discussions and the recommendations agreed upon by the participants. As will be seen, the Consultation was in concurrence on most of the questions discussed and devised a framework into which national land evaluation systems could fit. It was unanimous on the need for global land evaluation guidelines to be prepared.

The deliberations of the Consultation, the Background Document, the Check List for basic data collection, and other documents distributed at the Consultation can serve as starting points in this endeavour.

The editors

RECOMMENDATIONS

The Consultation recommends that:

1. Land evaluation be based on physical land attributes, insofar as they affect economic and other inputs, outputs and benefits within the context of specific "land utilization types", protection and enhancement of the environment, and socio-economic conditions.

2. Agricultural and other rural "land utilization types" (including new types which are actively contemplated for the near future), and also specifications for land improvement requirements be further examined and defined at different levels of generalization, by specialists and interdisciplinary working groups.

3. The essential concept of "major land qualities" (or the synonymous "major land conditions") be developed and related to "land utilization types".

4. The use of parametric and other methods in land evaluation be studied and elaborated, leading to a quantitative assessment of "major land conditions", inclusive of their combined effects and their relationships with inputs, outputs and economic parameters by systems analysis and systems methodology, in order to integrate the parametric methods within an overall scheme of qualitative and quantitative land evaluation.

5. Ecological requirements of individual crops and of "land utilization types" be systematically studied, possibly in connection with the soil data processing programmes of FAO and other agencies.

6. Field checks be undertaken as an essential part of land evaluation, with an intensity determined by data collection methods and by other aspects of resource surveys.

7. Studies be promoted of the concepts and methods of land resource surveys in order to satisfy the objections and needs of land evaluation as set out by this consultation.

8. Specific agronomic and other experimental work in all relevant ecological regions, including at "benchmark sites" of a long term nature, where monitoring of changes in the land and in land use is possible, be undertaken by national and international organizations (such as IITA) with the cooperation, when appropriate, of FAO and the Man and the Biosphere Programme of UNESCO, in order to ensure transfer of knowledge intended for immediate practical applications.

9. Interdisciplinary cooperation, teamwork and coordination be considered essential to adequate land evaluation, the assignments of team members being either simultaneous or staggered, according to survey requirements.

10. The "intersector" approach be adopted, to work towards the objective of rational land use in future by the closest possible liaison at planning and implementation stages between representatives of the interdisciplinary teams that have produced land evaluations and all other organizations (at local, regional, national and supra-national levels) and persons who have the same aspirations to adapt, enhance and control the environment.

The Consultation invites FAO to:

A. Arrange that the Background Document of this Consultation together with its glossary and other appendices be edited, if necessary with the aid of one or more interdisciplinary working groups, to include observations made at the Consultation, and be produced in a limited edition as a first approximation to a comprehensive manual on land evaluation.

B. Produce a publication on guidelines for land evaluation in order to standardize methods within the framework of the Background Document and to stimulate their application.

C. Issue as soon as convenient a résumé of the land evaluation framework and its implications for the use of those involved in planning and in the implementation of projects and for extension purposes.

D. Act as clearing house for information on ecological requirements of individual crops and of land utilization types, in connection with soil data processing programmes, when appropriate in collaboration with other international and with national organizations.

E. Study land evaluation including the production of land evaluation maps by interpretation of the FAO/UNESCO Soil Map of the World and available information at a comparable scale concerning climate and other environmental factors, in particular with regard to land development possibilities, limitations and degradation hazards.

F. Promote, in collaboration with UNESCO and other organizations, further interdisciplinary meetings and seminars on land evaluation, including specialists in the economic and social sciences, and to establish a secretariat to act as a focus on land evaluation matters and to foster the implementation of this and the foregoing recommendations.

TECHNICAL DISCUSSIONS

I. AIMS AND SCOPE OF THE CONSULTATION

Professor A.P.A.Vink, in his introductory remarks, stressed that the purpose of the Consultation was to formulate concrete conclusions on land evaluation methodology and that the background document had been prepared to assist this aim. The sequence of topics in the document might not appear very logical to the general reader but was specifically designed to guide discussion to the most essential points.

Professor Vink then summarized the various sections of the document, underlining the aspects which required special attention. In defining the scope of the Consultation, he foresaw difficulty in distinguishing between "a physical land classification with economic considerations" and an "economic land classification". He suggested that the former, the subject matter of the Consultation, was a study of physical variables with economic constants whilst the latter was a study of economic variables under certain physical conditions and lay beyond the scope of the Consultation.

It was understandable that a Consultation convened by FAO should be primarily concerned with agriculture. Nevertheless, there was need to recognize that land evaluation is carried out in a complicated socio-economic context and to keep in mind the problems that would be involved in answering unavoidable questions relating to non-agricultural uses, such as recreation, various kinds of environmental management and urban area planning.

Professor Vink touched briefly on the role of soil surveyors in land evaluation, recognizing that "land" was broader in concept than the subject of soil survey. He stressed that land evaluation has never been a monopoly of soil surveyors, although the object of their study - the soil - through its relatively permanent nature and continuous influence on human land use coupled with its flexibility to change through human input, had a special position amongst criteria of land evaluation. Sources of basic data for land evaluation other than the soil survey needed to be kept in mind and, whilst it was essential that the soil surveyor should take a part in land evaluation, a need for "land evaluation correlators" or "land evaluation experts" might be foreseen.

Professor Vink then pointed out some of the differences that would need to exist in land evaluations based on surveys at different intensities undertaken for different purposes and stressed the importance of ensuring that the user would be

aware of the relative "position" of a given evaluation within the overall evaluation framework.[+] He also drew attention to the "land evaluation field check" (Background Document, section 9) suggesting that there was need to discuss the required nature of such a check and by whom it should be undertaken.

In conclusion, Professor Vink invited attention to six questions that might serve as special points of discussion during the Consultation:

1. Do we agree to develop a framework for a physical land evaluation with economic considerations?

2. Do we agree that diagnostic criteria for this classification should be purely physical but should be selected in relation to economic considerations?

3. Do we agree on the need, in all cases, for a field check for land evaluation?

4. Do we agree that although our initial efforts may have an agricultural bias, the framework should also be applicable for non-agricultural uses?

5. Do we consider ourselves sufficiently competent to develop a framework which in the near future should be finalized by a more multi-disciplinary group?

6. Do we agree that this framework should have a clear and concise system of presentation to be easily used by administrators, planners and engineers?

Discussion on the scope of land evaluation which followed showed agreement that land use planning is not included in land evaluation, but that the physical and part of the economic data for land use planning: an assessment of alternatives, should be provided by land evaluation.

The need for a multidisciplinary[++] approach was emphasized, land evaluation covering a complex of physical, social as well as economic aspects. Speakers stressed the need to distinguish a sequence of steps: Basic surveys, yielding physical data of long-term validity; soil suitability/land capability/aptitudes culturales classification for specific crops or specific use on the basis of purely physical/technical data, which would remain valid for at least intermediate periods;

[+] See also Session IX, p.46 and Fig.3, p.49

[++] An *interdisciplinary* team consists of specialists from related disciplines, working together mainly in the field of their common interest; in a *multidisciplinary* team, specialists from different disciplines co-operate for a common purpose, mainly working in their own fields.

Land evaluation also taking into account economic factors, requiring frequent modification in some cases, and resulting in a (generally small) number of alternatives for consideration in land-use planning.

It was recognized that already in the second step, social and economic aspects are involved, but in a general way: the capability or soil suitability classification is always made within a given socio-economic context, using assumptions about level of technology and inputs.

Some speakers advocated complementary analyses of physical and socio-economic phenomena in increasingly refined stages, leading to quantitative land suitability ratings in economic terms. It may be necessary to have a small interdisciplinary[+)] team comprising a soils man, an agronomist and a hydrologist or irrigation engineer, for example, in the early stages, and a larger multidisciplinary[+)] team also including economists and sociologists in the later stages of land evaluation.

Speakers advocated a physical framework for land evaluation, taking account of economic considerations, and the use of physical diagnostic (class determining) criteria. In soil suitability classification, these could refer to, for example, physical productivity under specified uses, while in land suitability classification economic considerations should influence the levels of the class determining criteria.

The discussion on field check of land evaluation emphasized that the interpreter[++)] should always have direct knowledge of the land to be classified ("a feel of the land").

A field check is essential, during or after the basic survey, to provide this direct knowledge if the interpreter or certain members of the team have not participated in the basic field survey. Many other reasons may necessitate a field check during or after the survey. Among these are:

- changing economic or development conditions, which may entail modifications in the evaluation
- new or other land utilization types to be considered
- fertility or productivity of the land changing to a new equilibrium after introduction of a new type of land utilization

+) see footnote +), p.12

++) In this summary the term *the interpreter* is used for *the person or group of persons actually doing the land evaluation*

- the use of parametric methods
- the use of production and input data from practical, private or collective, farm enterprises
- the extrapolations made during reconnaissance or exploratory surveys
- the need to separate permanent from correctable limitations for irrigated agriculture in surveys of presently unirrigated areas.

A field check jointly with other specialists, not necessarily directly involved in the land evaluation, is useful once the draft evaluation is complete and before final editing and issue. At that time the interpreter has the most balanced insight of the area as a whole.

A number of methods were suggested to improve predictions of net productivity or effects of new land utilization types, the data to be collected during basic survey or during evaluation, or to be incorporated at the time of field check. These included:

- rapid and relatively inexpensive pot tests
- "pot tests" using undisturbed profiles ("pedotrons")
- data collection from experimental farms or pilot schemes on identified land.

Very few data on the "soil science of crops" are yet available in coherent, printed form although there exist vast quantities of scattered data and field experience. These will need collection. A start has been made through the FAO Soil Data Bank, and the Benchmark Site Studies of the IITA (see also benchmark sites, Session IV).

II. THE CONCEPT OF LAND

Introducing this topic, Mr. T.Eren underlined the point that the term "land" means different things to different people.

As defined in the background document, "land" embraces the atmosphere, the soil and underlying geology, the hydrology, and the plants on, above and below a specific area of the earth's surface. It also includes the results of past and present human activities as well as the animals within this area, in so far as they exert a significant influence on the present and future uses of the land by man.

Within this broad concept other more limited and overlapping concepts of land can be identified: land as space, three-dimensional, unchangeable and fixed in

quantity; land as nature, defined in terms of natural or man-made ecosystems influenced by natural processes; land as a gene resource; land as a production factor, together with labour and capital; land as a consumer good or commodity as a support for highways, buildings etc.; land as a source of pleasure and recreation; land as location, in modern economy and politics; land as property, exerting so powerful an influence upon man's attitudes and actions; and, finally, the related legal and economic connotation of land as capital.

Clearly a parcel of land may be suited to several uses at a given time. Its value does not depend on physical characteristics alone but is greatly influenced by social requirements and economic considerations. Furthermore, the most appropriate use of land should not be judged in a purely local context; account should be taken of the influence of each possible use on other tracts of land.

Mr. Eren invited discussion of the following questions:

1. For purposes of land evaluation, is it desirable to define land in terms of a broader range of natural environmental factors than has been customary in the past?

If so:

2. Is the definition of land proposed in the background document generally acceptable or in what way should it be improved?

3. Within a broad definition, which concepts should be included in all evaluations and which should be considered under specific conditions only?

4. What are the practical consequences of using a broader definition of land in terms of required land evaluation procedure and in terms of the required organization of institutions engaged in this work?

In the discussion which followed, participants agreed on the need to distinguish "soil" and "land" in the context of resource evaluation. The definition of "land" proposed in the background document was generally accepted, although it was recognized that further experience may suggest minor improvements to the wording. Consideration of the consequences of accepting this broad concept of land provoked lively discussion.

It was suggested that "soil" is a term in natural science; kinds of soil being areas defined in terms of features relevant to their genesis and physical behaviour. In contrast "land" is a term in social science. Kinds of land being areas, or tracts, defined in terms of the features and relationships relevant to their use for producing something and to their value as property. Another speaker sug-

gested that "soil" and "land" differed not only in their breadth of concept but also in terms of their identity with reality - mapped areas of soil representing concepts, those of land tending to represent unique tracts of the earth's surface.

Several participants recognized a similarity between the broad concept of "land" and that of "ecosystem". One speaker considered that vegetation should be excluded from the attributes of land in order to distinguish the two concepts. Another pointed out that tracts of land are always characterized by more or less strict boundaries whereas ecosystems are usually centrally defined concepts.

Difficulty in establishing standardized terminology for these concepts was seen to be increased by differences in language and in national procedure. In Portugal, for example, land planning and land evaluation is based on the "ecological station". This concept is defined as an approximately homogeneous ecological unit with a certain phytosociological, pedological, climatic and agrotypical expression.

In relation to land evaluation, the importance of the influence of man upon the attributes of land was stressed and it was suggested that the concept of land was especially close to that of "agro-ecosystem" or "cultural ecosystem": man-made or man-transformed ecosystem. In considering the many attributes of land it would be useful to distinguish those that are selfregulating from those that are controllable by man. Reference was made to the phrase "results of past and present human activity" in the definition of land proposed in the Background Document. This was considered to cover institutional attributes (ownership, water district regulations, administrative boundaries, etc.) as well as physical artefacts (roads, dykes, etc.), thought to be essential attributes of land with regard to human ecology.

The extent to which socio-economic attributes should be ascribed to land was discussed. One speaker, in particular, drew attention to the importance of establishing the status of ownership and the potential of the people living on the land as well as the availability of communications and of processing industries in order to determine feasible alternatives of land use. In reply, it was pointed out that although socio-economic attributes are specifically excluded from the proposed definition of "land", this is done on the understanding that socio-economic factors will be taken into account, to varying extent, in the actual process of interpretative land classification (Background Document 4.2.1, note a).

No consensus of opinion was reached on the extent to which the location of land tracts should be taken into account during land evaluation. Some speakers

considered that location was an important aspect of land evaluation and that the attribute of location should be clearly identified in the definition of land. The greater value of land to which access is available was cited. None questioned the practical and economic significance of location but several expressed the view that full economic consideration of this factor should be postponed until a later stage of land evaluation or the land-use planning stage. Concern was expressed that premature attention to problems of access and processing might prejudice development. It was stressed that the capability of land to produce a certain crop is not dependent upon its proximity to a road or to a market, although these factors may determine the suitability of this use in economic terms.

The role of animals in the concept of land was also questioned and a distinction was drawn in this respect between domesticated and wild animals. In general terms, the former were seen to be associated with specific tracts of land whilst the latter were not respecters of property boundaries and represented a less easily assessed influence. In either case, however, the proposed definition considered animals on the land only to the extent that they "exert a significant influence on present and past uses of the land by man". A speaker pointed out the varied requirements of wildlife and, with particular reference to the evaluation of wildlife habitat and recreational possibilities, stressed the need to extend evaluations beyond the limits of individual units to examine relationships between units. Whilst homogeneity in physical attributes would be an important characteristic of land units identified for interpretation of agricultural suitability, varied conditions were likely to be desirable within units selected for wildlife and recreation. The well known preference of wildlife species and of man for "edges" was stressed.

One speaker presented an alternative description of land expressed in terms of three main conditions; land surface (climate, topography, landcover of vegetation and stones); soil profile; and subsurface drainage (depth and quality of ground water, drainability)[+)]. This approach he suggested would facilitate understanding of land and ensure that appropriate studies were undertaken for irrigation development.

Another speaker drew attention to the proposed definition of "soil" (Background Document 4.2.1, ii) and suggested an addition stating that site attributes are not necessarily definitive of soils but are useful additional information. Not all

[+)] detailed description in: W.F.J.van BEERS (1972), see Documentation

pedologists, he considered, would accept land configuration (notably gradient; slope-complexity and microtopography) as a criterion for soil differentiation.

The session was concluded with a very brief discussion of land as a capital asset. While it was agreed that an absolute value of land at a given moment was an important consideration in use planning it was often not taken into account in land evaluation. Even appraisals of economic feasibility are usually confined to a comparison of inputs and outputs under "with-project" and "without-project" conditions: for example, only rarely is the market value or change in market value taken into account.

III. LAND UTILIZATION TYPES, CONCEPT AND PROPOSALS

Introducing this subject, Mr.K.J.Beek highlighted aspects from section 4.2.2 of the Background Document to clarify the concept of land utilization types. As an illustration of the need for properly defined land utilization types, Mr.Beek noted that in some land evaluation reports the user needs to go through the whole report to search, with or without success, for key attributes of a land use identified only in terms of produce.

A land use may need to be defined to help the interpreter in framing sound interpretations. If assumptions of classification are not stated, erroneous or apparently erroneous interpretations may result.

Mr.Beek stressed the importance of present land use, both as a yardstick for the comparison of planned uses and as a relevant use to be considered in evaluation. He referred to studies on present land use which could help in the definition of land utilization types, viz. the FAO World Agricultural Census and the land use classification of the International Geographical Union (by Kostrowicki et al.).

Four questions were put to the Consultation by Mr.Beek at the close of his introduction:

1. Does the Consultation recognize a need for defined land utilization types?

2. Is there a place for the concept in the different national systems of land evaluation?

If so:

3. What attributes are important and what degree of detail is required in the definition of land utilization types?

4. Is the Consultation in favour of co-ordination with classifications of present land use?

During the discussion which followed, strong support for the concept of land utilization types as a means of sharply defining the subject matter of land evaluation came from participants primarily concerned with work in developing countries. The value of the concept as an aid to the exchange of information between countries was also generally accepted. Some speakers expressed reservations about its application in developed, industrialized countries but even for these countries the concept did not lack support.

In relation to industrialized countries, concern centred on the possibility that short-term economic effects would overwhelm the influence of physical land factors in determining the suitability of land for separate land utilization types. Government economic controls, effected through subsidies and taxes, often appear to enhance this possibility.

Some speakers felt the concept might be especially hard to apply in lowland areas with evolved and stable agriculture and that in these circumstances, the identification of alternative land utilization types might represent a departure from land evaluation into the realms of land-use planning. However, other speakers pointed out that pressures for change often became very high in these countries (Hawaii was used as an example) and the land utilization type could then provide a valuable means of identifying use alternatives. This would be especially true if non-agricultural uses such as airports and urban expansion were included.

In considering the present proposals for the definition of land utilization types given in the Background Document and in a supporting paper by Mr.Beek, speakers made a number of suggestions regarding the choice of attributes. It was emphasized that key attributes of the land utilization types were those that would influence the inputs required and the outputs to be obtained.

The proposed attributes "farm size" and "land tenure" drew particular discussion and the differing viewpoints expressed illustrated the need to adapt the definition of land utilization types to local conditions. Not all factors would be relevant under all conditions. A resource survey in Western Ireland led to a recommendation to Government indicating need for a tenfold increase in the average size of farms if farmers were to obtain a viable income. Changes in land tenure were also recommended since much land was held in "commonage" without use of fertilizer or fencing.These factors were also considered to be very important in Pakistan and in the humid tropics, where lack of foreign exchange and thus of fertilizers often

made it necessary to adapt the kind of cropping to the size of holding that could be efficiently managed (examples from Rwanda and the Amazon basin were quoted). Land tenure, on the other hand, would be especially significant in countries where agrarian reform was in progress, such as Chile.

Suggested additions to the list of attributes with particular reference to conditions in Pakistan included:

- the type of irrigation
- the intensity of irrigation - the specified quantity of water in relation to the area of land
- the normal quality of available irrigation water in the area as a whole
- the presence or absence in the area as a whole of drainage or drainage possibilities where needed.

The availability and quality of irrigation water on specific land would be land qualities, as would be the presence or absence of needed drainage in specific tracts of land.

It was also suggested that the outlook and attitudes of land users, especially farmers and foresters, could be usefully added to the list of key attributes of land utilization types. This would recognize that, wherever land utilization options are available, the true capability of land depends as much on what the users wish to do and the standard of living they wish to achieve as on what is technically possible.

One speaker pointed out that certain utilization types may induce a progressive change in the character of the land particularly in relation to soil fertility, which may increase or decrease. This change itself may necessitate a modification of the utilization type in time. In fact, the useful life of evaluations based on the land evaluation type was a subject which attracted several comments. One speaker expressed concern that the useful life would be extremely short in relation to the long term programme of a systematic soil survey, especially under the economic pressures of developing countries. This was generally accepted but it was emphasized that, if need be, new interpretations could and should be developed from the stable basic resource data whenever change was required. At the same time a certain minimum level of stability in interpretations was thought to be desirable particularly to permit valid exchange of experience between countries.

Reference was also made for the need for interpretative maps with a "medium-term" useful life of ten years or more, corresponding to the mapping of, for example, "land capability" or the French "cartes d'aptitudes culturales". Such maps are

based mainly on soil characteristics and on general ecological conditions, in particular climate. They cannot take account of relatively short term economic considerations.

There was active discussion on the future development of the land utilization type concept. Some considered it would be useful to develop a list and perhaps a classification of alternatives of land utilization. It was recognized that such a typology could include a very large range of possibilities. Recognizing the danger of developing an inappropriate or excessively numerous range of alternatives, doubts were expressed whether the present group was sufficiently multi-disciplinary in its composition to undertake the task. The need for additional expertise especially in the field of agricultural economics and farm management was recognized.

It was suggested that a typology would need to include new land utilization types which could be expected to develop within the not too distant future. Non-agricultural land utilization types (in particular various kinds of recreation, sport fields, camping sites, etc.) should also be included.

The need to consider forest utilization types was stressed. Early identification of use possibilities was thought to be essential, especially in those countries fortunate enough to possess undeveloped land. Recognizing that "only the most promising alternatives would be selected for development" the need to consider "non-development", or wilderness, as a possibly desirable utilization type was mentioned.

There was discussion of the required level of generalization of the land utilization type with particular reference to the intensity, or mapping scale, of various studies. A need to group types, (also to group crops within land utilization types) at the lower intensities of survey was foreseen. It was suggested that the terminology "type" might be reserved for a basic, perhaps most detailed element of an hierarchy of land use. Terms such as land utilization system, or family, could be used at broader levels of generalization. It was also suggested that at the highest level of generalization alternatives of use might be distinguished such as "forestry", "horticulture", "dry-land farming" etc. At a second level, distinctions might be based on broad levels of technological input and at a third level on specific crops or even varieties, either in rotation or as single crops. The relationship between the levels of generalization of land utilization types and the intensity or scale of studies was also discussed.

One participant proposed a classification at the highest level in terms of capital

intensity, labour intensity and farm power expressed in monetary terms. The percentage of total production costs represented by the cost of soil could also be used as a high-level diagnostic criterion of land utilization type. He quoted figures from The Netherlands showing the wide range in this value. Only at a lower level should the factors know-how, farm size and land tenure be used, since they partly interact with the three first mentioned. The factor produce, being strongly influenced by the land suitability, would seem less suitable as a defining attribute of land utilization types.

It was questioned to what extent it was desirable to create standard land utilization types, rather than accept ad hoc recognition and specification by multi-disciplinary teams to meet immediate interpretative needs. It was agreed that while a typology would provide guidance, rigid standardization might be undesirable. More important, perhaps, would be agreement upon key attributes used to define the utilization types. Again in this context, there was a reminder of the need to recognize the management requirements of forestry, the use of helicopters for logging being cited as a very specialized example.

A warning was given on the difficulties of multi-disciplinary cooperation associated with the differences in method and focus involved. It was not possible, the speaker believed, to define types of land utilization by adding together different variables. Land utilization is a balance which changes every day. The difficulties encountered by the Commission on Agricultural Typology of the International Geographical Union chaired by professor Kostrowicki were cited by way of example. Only after eight years had it been possible to obtain agreement upon a typology based on 20 variables. It was thought that all of these variables would prove useful in the understanding of land utilization. The Consultation agreed that maximum use should be made of the work of this IGU Commission in developing the land utilization type concept.

The place of the land utilization type in the overall procedure of land evaluation was also briefly discussed. The selection of relevant utilization types in terms of prevailing physical, social and economic conditions - the first step in the proposed procedure - was seen to go part of the way to solving the problem of location. Types of utilization that were inappropriate for reasons of access or because of lack of markets would not be regarded as relevant in most cases. One speaker mentioned the need for a market study following upon basic data collection, to orient the selection of relevant utilization types. In this context the importance of secondary benefits, such as conservation, recreation, and improvement of the atmosphere which might be associated, for example, with forest production, was stressed.

The possible interaction between adjacent land utilization types, and their positive or negative role in respect to environmental conservation also received brief attention in this session. Two aspects of environmental control were noted: on the one hand excluding human activity, and on the other mobilizing effort to preserve balance in man-made ecosystems. Human activities that adversely affected the quality of the fresh water supply received special mention in relation to selecting appropriate utilization types.

IV. DIAGNOSTIC CRITERIA AND INPUTS

This session was held in two parts: the first dealing with inputs and the second mainly with diagnostic criteria, but also with the value and purpose of land evaluation and the requirements of planners.

Introducing the first part, professor J. Bennema stated that land evaluation embraces inputs as well as outputs and especially the relation between the two. In the Background Document, inputs have been divided between recurrent and capital inputs. Synonyms for the latter are development or non-recurrent inputs (costs).

Recurrent inputs are partly determined by the land utilization type. For each utilization type, there is a minimum level of recurrent inputs for land with optimal conditions. Limitations (sub-optimal conditions) cause an increase in required inputs beyond this minimum level.

The limitations of each mapped land unit can be used in low-intensity studies as an indication of the general level of required inputs. In high-intensity studies the required inputs should be analysed in relation to the management practices. In this case management specifications will need to be defined.

In the case of capital inputs it will be necessary to make improvement specifications: to identify the improvements needed and the methods to realize them.

The following questions could be discussed:

1. Do the participants agree that land classification should deal with inputs and outputs and not with outputs alone?

2. Is there agreement that in low-intensity studies, input levels can be roughly estimated on the basis of physical limitations of the land, whereas in high-intensity studies inputs should be in relation to the practices and needed improvements, which requires the definition of management and improvement specifications?

In the discussion which followed it was agreed that with few exceptions, such as the collection of wild forest products, inputs are essential for production and should be considered in land evaluation. The higher the technological level of the use considered, the more important is the detailed specification of inputs.

Apart from the level of technology, the level of detail of the survey influences the degree of emphasis on input specifications. Where little information on inputs is available, assessment of physical limitations needs to play a correspondingly greater part in the evaluation.

The effect of a given input should not be evaluated in isolation but with consideration of its interactions with other inputs and management practices in the context of the total land utilization type.

One speaker suggested that the level of inputs be determined by economists or planners. It was agreed that in the beginning of the evaluation process, economists should participate with other team members in the specification of general input levels.

Differences in suitability (or in the negative: differences in degree of limitations) may manifest themselves in two ways: by differences in gross productivity at constant input level, or by different input levels required to achieve a specific gross productivity. Both ways show the close relation between suitability and net productivity.

Speakers pointed out a need to revise the term "capital" inputs, since capital expenditure is not always involved. Labour may be the main factor in non-recurring inputs, and may not always have a "capital" value. "Non-recurrent inputs" was proposed as an alternative term.

Summarizing the discussion on the subject, a "major improvement" could be defined as a non-recurrent activity causing a change in land conditions expected to last for a period longer than one or two decades, and requiring capital or labour inputs beyond the normal scope of the land user (individual, collective or other unit of production: estate, unit of forest management, etc.). It became clear that the boundary between major and other improvements is not sharp, and moreover varies with the socio-economic context (different countries, regions, uses).

Land pattern was recognized as positively or negatively influencing land use and required inputs. Sustained use might depend upon a combination of different kinds of land. Examples included grazing, requiring land with different drainage and

nutrient characteristics, and wildlife requiring a range of sites for survival. Land pattern could be a negative factor where variability over short distances would either make a uniform management procedure sub-optimal in parts of a field, with consequently lower productivity, or necessitate land improvements on such parts.

In his introduction to the second part of the session, professor Bennema dealt with diagnostic criteria: measures for the degree to which land conditions satisfy the requirements of the use under consideration.

The suitability of the land for a certain use is determined by the extent to which the requirements of that use are met by the relevant land conditions. Examples of land conditions relevant to plant production are:

- ecological conditions such as availability of water for plant growth, availability of oxygen for root growth, availability of radiation
- conditions influencing management such as possibilities for mechanization, resistance to soil erosion
- conditions related to improvement possibilities such as response to fertilizers, possibilities for irrigation.

These relevant land conditions professor Bennema explained are called major land qualities in the Background Document. A major land quality can be defined as a land condition or land characteristic which has a direct bearing on a basic requirement of the use, or in other words, which answers a basic demand of the use. He stressed that it should answer a basic demand. Such a basic demand for plant growth is water, for example, and the demand is met by the availability of water. Land characteristics like texture, soil depth, and precipitation are determinants for the level of available water, but are not major land qualities.

From the definition of major land quality it follows that land suitability (for a specific use and within a certain socio-economic context) is a function of the major land qualities.

For each land use a set of major land qualities is relevant, and the same major qualities often occur in more than one set. A limited number of qualities are relevant in land evaluation, therefore.

The concept of major land qualities is in the tradition of limitations, but the concept is more general. A certain level or rating of a major land quality might represent a limitation for one land utilization type, while it is optimal for another utilization type. Major land qualities can be rated irrespective of a

utilization type, in contrast to limitations. The rating of a major land quality - the quality classification - forms a step between the data collection and the suitability classification. The use of this step enhances the flexibility of the land evaluation procedure, because the same ratings can be used for different utilization types.

The level of a major land quality is determined by a set of interacting single or compound land characteristics. This level can be rated in different ways:

- from its constituent properties, by using either parametric methods or other models
- by observing the reaction of plant life, animal life, farm management etc. on the levels of the prevailing land qualities
- or by a combination of these two.

How a certain level of a major land quality affects yield, management or improvement possibilities and, through this, land suitability, should be established for each case separately. The way in which this is done depends strongly on the kind of quality and the kind of land use.
Although land conditions affecting management and improvement are very important, much of the current discussion about diagnostic criteria seems to center around the yield potential and the factors affecting it.

The production potential can be determined by using a growth function depending upon the ecological major qualities. Measured yields and calculated levels of major qualities may be used to solve this equation. Production potential may also be handled as a major quality itself, however, and can be estimated either by direct measurements or through established relations between single or compound land characteristics and yield on a local geographical basis (parametric method). This last approach will often require additional information about the influence of the basic growth factors (major ecological qualities) as a basis for determining proper management and improvement.

To stimulate discussion professor Bennema asked participants to consider whether it was important:

- to use and develop further the concept of major land qualities and if so, in what direction. Which other major land qualities can be identified?
- to use and develop further the parametric method for the determination of yield potential and if so, in what direction?
- to try to find a synthesis of the parametric method and the concept of major land qualities?

The discussion which followed centred on the concept of land qualities, the reasons for their recognition and possible methods of description and rating. Speakers agreed that land characteristics in land evaluation do not occur in isolation but interact, and that they may usefully be grouped to facilitate evaluation of suitability. "Land qualities" were recognized as groups of land characteristics, each meeting a recognizable, reasonably distinct, requirement of the use - for example of plant growth, of recreation, of forest management - but not independent from each other. The degree to which the requirement is met is directly related to the level (rating) of the quality.

Land qualities may be used to summarize land data for a number of related land utilization types. They may be a useful vehicle to synthesize much scattered knowledge about the requirements of different crops.

Gross yield may be used as a main quality which should be combined with other qualities determining the levels of inputs to arrive at a suitability classification.

It was stressed that a "feel of the land" was not enough for sound evaluation, and that measurable criteria should be used wherever possible to quantify the basis of evaluation.

Speakers suggested that many land qualities (including productivity, for example) could be determined directly using information available by kinds of soil, management history plus present use, and climate data (stored moisture). A model approach could also be used to arrive at quantitative expression of land qualities. Parametric methods could be useful in the elaboration of models, and have been used for estimations of gross yield. Quoted examples of such use came from the Canadian forest suitability classification; a study of rice yield on 13 soils in N.E.Thailand; and a study on maize yield in Swaziland.

Proponents of the parametric method cautioned that this method should only be used by experts with great experience in land evaluation, since otherwise it can be very misleading.[+)] Speakers suggested that a check should be made on model methods through input and productivity measurements.

Different speakers suggested additions to the list of qualities given in the Background Document. These included the presence of ecological gradients and breeding places for wildlife; resistance to deterioration other than erosion; capacity to sustain a certain rate of pollution; response to fertilizers; absence of weeds;

+) extensive discussion on parametric methods in Session VI, pp.38-40

absence of toxic conditions (like presence of soluble Al, high soluble Mn concentration); and solar radiation energy (for global classification). Also landform and drainage, history of use and present use practices were suggested as possible qualities. These are important factors in land evaluation, but the first two already constitute parts of different land qualities mainly of "availability of moisture", while the last two can be seen as part of the land utilization type specifications.

It was noted that not all aspects of the listed subjects are necessarily land qualities: pests and diseases, for example, may be relatively independent of kinds of land but strongly dependent upon management practices. Under this heading land-borne (endemic) pests and diseases were meant, professor Bennema explained.

Different terms were suggested to replace "qualities", one speaker coining the term "antiqualities" to illustrate the fact that positive and negative qualities are listed in the Background Document. Suggested terms included: major land attributes; major land conditions; major land conditions for plant growth; major land conditions from the point of view of plant growth. No term found so far combines brevity; equal applicability to the requirements of plant growth, management, wild life, recreation, etc.; and the clear implication that the group of diagnostic criteria is viewed from the point of view of a requirement, not by and for itself.

Study of "benchmark sites" was suggested to accelerate the build-up of information on major land qualities, on productivity and on the inputs of some main land utilization types. Benchmark sites in a number of defined environmental (ecological or agro-ecological) units could provide information on actual and potential use (and non-use) of land, including the effects of different kinds of management and leading to long-term productivity. Benchmark sites could include nature reserves, experiment stations, and toposequences in humid tropical regions as suggested by IITA.

The discussion widened in scope to the value and purpose of land evaluation and the kind and quality of evaluation needed by planners. Points which received emphasis included:

- that the value of land evaluation lies in the use of its results to land use planning and that one of its main purposes is to indicate the economic consequences of alternative land use decisions

- that an intersector approach[+)] (at least agriculture - forestry - recreation - wildlife) is required after the separate evaluations for single uses to realize this value and achieve this object. Land evaluation data should be quickly available and immediately usable by the planner
- that planning and investment decisions require information on output and input (feasibility studies) based upon basic resource data ("climate, soil, water, people"); inputs (project costs); and specifications of management and infrastructure
- that land evaluation data in feasibility studies to date are very variable in quality, degree of detail and sophistication. Often, the assumptions made in the classification are insufficiently spelled out, or economic factors determining suitability omitted from consideration. Constraints (limitations) are listed but often are not evaluated, equal weights being given, for example, to salinity (correctable) and permeability (non-correctable)
- that criteria for classification often are not specified, but covered by a phrase as "having been taken into consideration".

A need was seen for a short, simple set of directions for land evaluation, which planners and users can refer to conveniently.

The Consultation was informed that FAO intends to issue a booklet entitled "Guidelines for land evaluation" for a very wide distribution, as a first approximation, on the basis of this Consultation and further discussions. Land evaluation is necessarily complex, as evident from the discussions, and a simple guideline will have to be condensed from a large amount of information. This will cause some loss of detail.

Another consultation, with more participation from the users' side, was proposed for 1974-75, to test the work done until that time.

+) An *intersector* approach involves the integration of land suitability evaluations for a number of uses that are interrelated or partly conflicting (different sectors of use like dry-land agriculture, grazing, wildlife, for example) into one or a small number of alternative land-use plans. The separate suitability classifications used should be quantitative (in economic terms) where possible.Factors like social value or irreplaceability (nature reserves, water supply areas for example) will also need to be quantified or ranked. Only then can they be assigned weights in the intersector planning process, which requires explicit criteria and methods for optimalization, ranking or selection of uses for specific land mapping units.

V. SPECIFICATION OF BASIC DATA

Introducing this item, Mr.J.L.Unger recalled that, when he was asked to prepare a checklist of basic data for land evaluation, the first questions which had sprung to his mind had been "why, how and by whom?"

Answering the question "why prepare a check list?", Mr.Unger suggested that there was an obvious need for an inventory of data requirements in a multidisciplinary study of land, on the one hand to avoid overlooking essential information, and on the other, to avoid professional "hobbyism" or overlapping. Such an inventory is needed in the preparation of detailed terms of reference for surveys, and for planning the use of manpower. It would promote uniformity and continuity of survey methods and, by clearly indicating data needs, would encourage the supply of "tailor-made" data from sources external to the survey itself.

The question "How to draw up a check list?" raised a number of difficult problems associated with grouping the various items to assist readability and access to the list. Mr.Unger had chosen to group the items according to disciplines and to certain objectives commonly envisaged in rural development. Although items were frequently related to more than one discipline they were listed only under the discipline which in practical survey experience was thought most likely to handle the item. This procedure avoided repetition but led to the elimination of certain apparently important disciplines, notably geomorphology and agronomy (the former is dealt with in the checklist under "soil conditions", the latter mainly under "economy"). The grouping according to objectives was presented in the form of a tabular synopsis in the checklist. A further subdivision of the items relevant at three levels of survey intensity - reconnaissance, semi-detailed and detailed - was included in an early draft of the list, but later discarded because the importance of the distinctions drawn did not justify the additional complexity.

The number of disciplines included in the checklist is large, said Mr.Unger, because evaluation of land potential needed to relate to the complete environment. Those who were concerned about the ephemeral nature of some items, notably in the social, economic and institutional fields, should bear in mind the capacity of modern technology to change an increasing proportion of the physical land characteristics which one tends to regard as permanent. Land evaluation itself is never permanent but requires constant review.

Finally, questioning who should continue to edit and contribute to the checklist, Mr.Unger stressed that the present list could be substantially improved and elaborated and that it would have to be kept up to date in the light of new technology.

Should the list grow appreciably in the future, computer storage and access might be necessary to ensure that data requirements pertinent to specific survey conditions could be identified.

The following questions were proposed for discussion:

1. Is there agreement that a checklist can be useful and that it must meet specific requirements?

2. Should we aim at a certain grouping of the individual items to increase its readibility?

3. Should we try to arrive at more uniformity in classes of the individual items or should we leave it to the discretion of the surveyors to distinguish classes?

4. Is it considered useful to establish a kind of central secretariat where a checklist is continuously improved and kept up to date?

There was general agreement that a checklist for basic data collection was useful and that Mr.Unger had performed a very useful service in preparing his meticulous list. Speakers differed however, in their views on the way in which data should be grouped and presented.

It was pointed out that checklists were essential when computer processing of data was used or foreseen in the near future.

Concern was expressed about the variety and quantity of data listed and it was suggested that these varied greatly at different intensities, or scales, of study. Again it was emphasized, however, that land evaluation was team work and that, whilst a soil specialist should familiarize himself as much as possible with the requirements of other disciplines and should assist in the collection of other forms of data during his field work, he must be supported by workers in other disciplines. In this context, it was suggested that a clearer grouping of the items of the checklist by disciplines was desirable. This would facilitate its use and also make it easier to bring specific sectors of the list to the attention of different working parties for development and improvement. The need to obtain specialist assistance in working out the different parts of the list was stressed. General agreement would be needed on each of the classes of data to be recognized and this would be long and difficult work.

Particularly in view of the large number of items involved, it was suggested that it would be worthwhile to indicate the highest priority items in each column of the checklist. Bold printing might serve this purpose. The priority items

should be those having the greatest stability or permanence and, on the physical side, would include some climatic, geodetic, topographic, geomorphologic and pedologic items. High priorities in the socio-economic field would also have to be identified. Where survey time was limited, in other words nearly always, effort would concentrate on the collection of these high priority items in preference to compilation of an over-generalized catalogue of all elements of the biosphere.

Another suggestion from the same speaker was for the indication of time-limits, analogous to the date stamping of perishables, on evaluations as well as on collected basic data. Most ratings have only temporary validity and misunderstanding could be avoided by showing a date beyond which the information may no longer be reliable. At the same time the procedure would serve to emphasize that land capability ratings are of a transient, dynamically evolving nature.

The various references to the need for teamwork drew attention to the problems of employers who are called upon to assemble survey teams at a given time and place - sometimes a difficult and expensive task. It was pointed out, however, that teamwork could also mean co-operation between individuals already working in different ministries or institutions in the country concerned and already familiar with various aspects of the survey area. Such co-operation was not always easy to obtain but it should be fostered by continual emphasis upon the multidisciplinary nature of land evaluation. One speaker emphasized that a multidisciplinary exercise is not achieved by merely adding together the contributions of separate workers but must be approached in a group spirit, each worker being influenced in his work and in his findings by those of his colleagues. Finally a collective conclusion is required from the team.

In discussing the details of the checklist a number of suggestions were made concerning arrangement and content. Proposals for grouping the data included:

- grouping in accordance with specialist interest
- grouping of characteristics in terms of land qualities
- grouping in relation to geomorphological units
- grouping in relation to soil taxonomy.

This last suggestion drew particular support on the grounds that taxonomic identification served as a synthesis of very many soil physical and genetic factors essential to the understanding of soils and the assessment of their contribution to the overall evaluation of land.

Since the evaluation was required to develop in stages an attempt should be made to arrange the checklist in equivalent stages.

It was also suggested that thought might be given to ways in which the checklist might serve the identification of problems associated with production and conservation which would be fundamental to sound evaluation.

By analogy to the pilot's pre-flight check it was suggested that the list might include checks upon the nature and efficiency of equipment used. Methods used should be identified not only in relation to laboratory analysis, but also in relation to the use of air photography and other forms of remote sensing.

A reference was made to the difficulty of assessing grazing potential and to the criteria involved. In this connection Dr Gardiner described recent work in Ireland leading to the production of a Grazing Potential map of the country based on the General Soil Map of Ireland (1969) and more detailed grazing maps relating to four counties. Figures for "actual" grazing capacity were obtained from statistics and "potential" values were obtained from benchmark sites and research stations. It is noteworthy that field checks were found to be very necessary following the desk study.

The discussion widened to other aspects, and Dr Krastanov described the various stages which, in his view, should constitute the procedure of land evaluation.[+)] He started by emphasizing the importance of basic data, and thus of the checklist, as a foundation for land evaluation. The first stage aimed to answer the question whether the land is suitable or not for agriculture. The answer can be based, he considered, on a small number (not more than 10-15) of physical and economic criteria such as stonines, level of the water table, soil depth, erodibility together with some physico-geographical indices such as steepness of slope, altitude, rainfall, etc. Some general economic criteria are needed at this stage to compile what may provisionally be called a "potential land productivity rating" (existing productivity corrected by a coefficient derived from pilot experiments and farms).

The parametric approach, Dr Krastanov believed, seems to be the best one,[++)] and the best method a regression factorial analysis preceded by an analysis of main components. He called upon FAO to support investigations aimed at developing the best methods and the best selection of physical and economic criteria.

At the second stage of project preparation, it would be necessary to answer to what degree the land was suitable for agriculture, which the speaker termed "land

[+)] see also Session IX, p.46

[++)] see also Session IV, p.23 and extensive discussion in Session VI, pp.34-40

productivity evaluation". Only physical criteria should be used at this stage. But it is necessary to evaluate in terms of different crops and an important question is to establish the socio-economic conditions and level of management, which will provide the setting of the evaluation. He proposed that the best existing socio-economic conditions and average level of management for the country in question should be used. It will also be useful to try to predict the future levels of management and technology of production. Finally it is necessary to determine how to use the land. This can only be answered on the basis of land productivity evaluation supplemented by a large amount of additional economic criteria. The natural conditions now provide the background and the socio-economic criteria have primary importance. It is extremely difficult to select any generally significant socio-economic indices since these vary greatly from one country to another. Dr Krastanov concluded by expressing the view that the checklist provided an excellent source for selecting appropriate data for collection but that the latter must be specifically appropriate for the various stages of land evaluation.

VI. REQUIRED INTERPRETATIVE CLASSIFICATIONS

This topic was introduced by Dr A.J.Pecrot. He explained that the various types of classification proposed in the background document were intended to distinguish a few broad categories of interpretation differing in their precision and in their objectives, requirements and assumptions. The distinctions were intended to help the user to understand the exact significance of each classification.

The first distinction was made between qualitative and quantitative classifications. Use of the description "quantitative" was reserved to inform the user that the interpretative groupings were distinguished in precise numerical economic terms. Such a classification, Dr Pecrot pointed out, would permit comparison of suitability for unlike land utilization types. Classifications which did not meet this requirement would be described as qualitative although they might be based on varying amounts of quantitative data on yields, required inputs, etc.

Actual and potential suitability classifications represented a second level of distinction. The user would know that an actual suitability classification reflected the present condition of the land and was based on direct observations, whereas a potential suitability classification reflected a future situation, after the land in question had been changed by a major improvement. Since major im-

provements are assumed to require heavy capital expenditure, it is proposed to further subdivide the potential suitability classification ("with" or "without amortization") depending upon whether or not the amortization of this capital expenditure has been taken into account in evaluating suitability. Dr Pecrot gave examples of situations in which the problem of assessing the level of amortization differed in difficulty and in importance.[+)]

The broad categories of classification embraced many intermediate situations (qualitative-quantitative; actual-potential; with-without amortization). Mutually exclusive definitions were desirable but the two committees recognized that these had not yet been achieved. Especially difficult was the definition of the concept of "major improvement" which served to distinguish actual and potential classifications.

Dr Pecrot suggested that the following questions merited discussion:

1. Are the various kinds of classification justified or useful?
2. Is it acceptable to base the difference actual/potential on the concept of major improvement?
3. How can we amend the definition of major improvements so that the concept is applicable to all broad utilization types including primitive agriculture?
4. Is there a better term for "major improvement"?
5. "Major capital input" is confusing. Can we recommend an alternative term?

The desirability of distinguishing the various classifications proposed was then very actively debated. Particular attention was given to the distinction between "actual" and "potential" suitability classifications. Those who opposed the distinction were concerned about terminology, or the difficulty of adequately distinguishing the two concepts, or feared that it would make the evaluation framework too complex. Supporters believed that it would provide greater flexibility and precision in the presentation of evaluations.They considered that a comparison of the two classifications would indicate where land limitations were correctable at acceptable cost and thus spotlight land having a high "capacity for improvement". They also believed that the distinction would ensure that the user would not be left in doubt whether or not costly improvements were assumed in the evaluation.

Several speakers disliked the restricted meaning proposed for "potential" believing that all evaluations were made with a view to possible change in present land

[+)] An actual as well as a potential land suitability classification may be for different relevant uses, not only for the present land use.

use and that all such changes represented potential uses. It was pointed out that the "actual" suitability classification implied "classification of land suitability without major improvements" whereas "potential" suitability classification implied "suitability with major improvements". A suggestion to use the expressions "with" and "without major improvements" to identify the two classifications received support.

At the same time there was general agreement that the concept of "major improvement" required more concise definition. It was recognized that this was difficult since the level of significance to be attached to a particular improvement measure varied greatly in different socio-economic environments.

It was reported that two principal modes of soil transformation were distinguished in the Soviet Union: through amelioration effecting almost instant change, and through regularly applied agrotechniques effecting a gradual change over a substantial period of time. This was thought to be an important distinction and the expression "fundamental improvement" (as opposed to a "managerial improvement") was suggested to replace "major improvement". "Special improvement" and "significant improvement" were other alternatives suggested.

Another speaker referred to the economic appraisal of development projects in which, he said, a comparison of "with" and "without-the-project" benefits was very necessary. It was agreed that the land evaluation aspects of such a comparison would involve comparison of "actual" and "potential" suitability classifications if the project entailed major improvement of the land.

Another participant pointed out that development was often carried out in stages. He suggested that this might give an ambiguous meaning to "potential suitability" since different potentials would be reached at different stages.

Examples of staged approaches included:

- improved supply of surface water followed later by groundwater development
- widely spaced subsoil drainage with the expectation of decreasing the drain intervals at a later stage
- spate (flood) irrigation as a first stage with provision for water storage later
- deferred drainage.

A reclamation programme, it was suggested, might also lead to different stages of potential suitability. These different stages could be represented by separate land utilization types but the speaker believed that it might be difficult to evaluate the major improvements required to optimize the utilization type without a simulation programme.

Two speakers expressed the view that the various distinctions of actual and potential suitability classification; minor and major improvements; and of recurring and non-recurring inputs could be achieved by recognizing additional land utilization types. They believed this would be a simpler solution to the problem. It was suggested that if evaluations of land potential over large areas or over the whole globe are to be attempted, the range of levels of potential would be impossibly large and that certain standards would have to be worked out.

Considering the quantitative and economic aspects of the various classifications, one speaker stated that the only common yardstick of suitability in terms of both inputs and outputs, was the monetary unit. Qualitative evaluations of relative suitability can be usefully made in relation to a single use but cannot serve for comparison of unlike uses. Other speakers felt that a purely monetary yardstick, although necessary for essentially economic undertakings like agriculture, was not satisfactory in relation to environmental management.

Various speakers expressed concern over the inclusion of amortization of capital expenditure (or, as the Consultation preferred to express it, of "non-recurrent" expenditure) within the scheme of suitability classification. Some speakers pointed out that this would entail knowledge of interest rates and of the period of repayment. It was also pointed out that conditions of repayment for development were often artificially generous and could not be considered to reflect a true economic consideration of the indebtedness involved. It was suggested that these fears merely emphasized the essential nature of teamwork in land evaluation, for they represent problems that could and should be resolved by economists rather than natural resources specialists.

A participant stressed the importance of taking adequate account of recurrent management and maintenance costs associated with major non-recurrent inputs, especially in irrigation and drainage schemes. These are often overlooked.

Another speaker expressed the view that costs incurred outside the land tract in question, for example in constructing dams and canals, should be considered only in so far as they affect water charges, etc. Other participants emphasized, however, that it was important to establish exactly what the farmer will have to pay and not to give an unduly optimistic impression of suitability for a particular purpose by omitting significant associated costs.

The cost of land improvement might include significant expenditure on conservation works (windbreaks, etc.); the need for recurrent conservation practices might be foreseen in defining land utilization types and would influence recurrent costs of production.

It was explained in reply to a question that the procedures adopted by the US Bureau of Reclamation differed in different parts of the world. Within the United States, the Bureau was required by law to make its assessment of land suitability for irrigation in relation to the farmers capacity to pay the resulting charges. Elsewhere, suitability could often be assessed in terms of the benefits to be derived by the farmer measured as net income together, if appropriate, with non-economic benefits.

During the course of the discussion professor Vink defined the term "parameter", used in various contexts by various speakers, as a factor used in calculations. It is a variable, he said, within a formula but is, or is assumed to be, constant under certain circumstances, in contrast to the variables which are investigated as such. In the context of the Consultation parameters would be economic (attributes of the land utilization type and other general economic parameters) and the variables would be physical. He went on to express concern about the "so-called" parametric methods of assessing land or soil productivity and gave the following main objections to the use of parametric methods in land evaluation. In his view:

1. The principle is wrong because the same factor has a different influence on plant production depending on its interactions with other factors.

2. The principle is wrong because it does not sufficiently take into account the land utilization type and the inputs within this land utilization type.

3. The practical application is hazardous because the final figure from a formula may be the same but consists of different components with completely different practical implications with regard to recurrent and non-recurrent inputs.

4. Within a certain land utilization type there is a certain hierarchy of values for the various limitations. This hierarchy even varies for one utilization type within different kinds of land. This is completely neglected by the parametric method.

Professor Vink then expressed the opinion that the development of a more general ecological formula such as that of Nix (1968)[+)] offered a more promising direction for mathematical appraisal. He noted that the latest work of M.Riquier, circulated at the Consultation, was moving in this direction and suggested that there

[+)] Nix, H.A.: The Assessment of Biological Productivity. 1968. In: Land Evaluation (ed.G.A.Stewart).

was need to consult with experts in systems analysis and systems methodology to combine various approaches and to arrive at a mathematical approach of a nature that was sufficiently comprehensive and fundamental as to be satisfactory.

Time did not permit proponents of parametric methods to make a verbal reply to Mr.Vink's comments but, by mutual agreement the following summary of a written statement signed by Messrs.Frankart, Krastanov, Riquier, Sys and Teaci is included in the record.

Objection 1. The influence on productivity of interactions between different factors is evident; however, the effect can be determined quantitatively even when the mechanism of interaction remains unknown. It is also true that the effect of one factor is never reproduced identically even for a specific land type. Systematic reflection upon these considerations suggests it is impossible to elaborate any land evaluation system, quantitative or qualitative, parametric or otherwise.

Objection 2. This objection is not valid since the suggested parameters are determined at all times for a specific land utilization type or crop and for a given management system.

Objection 3. The fact that soils with different characteristics yield the same index is not a valid objection to parametric methods. The value of the index permits classification in a specific high level category of the classification system; the kind of limitation can easily be expressed in the lower categories. These limitations as well as their intensity may be indicated on the land suitability map.

Objection 4. As explained in relation to objection 2, these hierarchic values are taken into account in the choice of ratings for the various soil characteristics and limitations as well as in the definition of the kind and intensity of these limitations. Ratings of an important characteristic (limitation) can be spread over a wider scale than that used for less important characteristics.

The workers on parametric methods thus conclude that, in contrast to other methods, the parametric approach leads to calculated information on productivity which can be used by the economist. Benefit obtained from land use can be expressed in the following form:

> Net return per ha equals production per ha times selling price of produce minus cost per ha of land improvement requirements and cultural practices.

In this formula, parametric methods provide a quantitative measure of production

per hectare and of the intensity of land improvement requirements. The economist can convert this information to provide an economic land classification on a quantitative basis.[+)]

VII. INTERPRETATIVE CATEGORIES AND GROUPINGS

In his introduction, Mr.Smyth suggested that the interpretative groupings (classes, subclasses, etc.) are a topic of special importance since they provide the point of contact, of understanding or of misunderstanding, between the interpreter and the user of land evaluation data. In considering the proposals it is important, he said, to bear in mind that parallel interpretation for various alternatives of use was planned, possibly using more than one type of interpretative classification. The proposed framework of interpretative groupings is intended for use in each kind of interpretative classification and in relation to all kinds of land utilization types.

It was proposed to adopt the very widely accepted concepts of "class", "subclass" and "unit" as the three lower categories of a four-level classification framework. Mr.Smyth explained that no limitation was placed on the number of classes to be used since it was recognized that the optimum number of classes depends on the objectives of a survey and on the quantity and quality of available basic data. Flexibility in the number of classes recognized is risky in that users might be confused by differences in the basic meaning of a given class in different surveys. It was to minimize this risk that the highest level category was proposed: orders, denoting kind of suitability. All classes of land in Order 1 would be "suitable", all classes in Order 3 would be "unsuitable".

In explaining Order 2, Mr.Smyth pointed out that all interpretative classifications are developed on certain assumptions, some of which are related to the land utilization type in question or to the specifications for improvement that is foreseen. Quite frequently a part of the survey area may be "unsuitable" for a given use under the accepted specifications, although it would be "suitable" if one or more of these specifications were to be changed. This problem could be solved by elaborating a new land utilization type with modified specifications, but this is laborious and recognition of Order 2 (conditionally suitable) pro-

[+)] see also Session IV, p.23

vides a more convenient solution if the area concerned is small in relation to the survey area as a whole. The conditions under which land in Order 2 would be suitable have to be known and should be clearly identified at the subclass level in the map legend and text. Order 2 is not a "waste paper basket" in which "don't know" or "marginal" groupings might be placed.

In conclusion, Mr.Smyth suggested that the following questions might usefully be discussed:

1. Is it better to establish principles of interpretative grouping or to aim from the outset at a rigid structure of classes for general adoption?

In either case:

2. Do we accept the inclusion of classes, subclasses and units in the standard framework?

3. Do we consider the Order to be a useful category?

4. Do we consider the Conditionally Suitable Order to be a useful concept?

5. What improvements would we wish to make in the definitions proposed for the various categories in the Background Document?

In the discussion which followed agreement was expressed on the need for a set of unifying principles of land suitability classification rather than a rigid system. One such unifying principle could be the relative net benefit of the use anticipated, qualitative or with increasingly quantitative expression depending on the availability of quantitative (physical and economic) data. For example, quantification could be in terms of value per hectare, value per unit of irrigation water, possibly internal rate of return, but might not be possible in all cases (wildlife, some recreational uses). Use of the internal rate of return was discouraged by a speaker because of possible confusion with feasibility study and planning activities in which this value is calculated as a measure of economic feasibility of a project as a whole.

The proposed structure of the framework was generally agreed. The need for a common structural framework of classifications was also stressed from the point of view of the user, who suffers unnecessary difficulties and delays if forced to use different classification systems (for example, in drawing comparisons between different projects). Doubts were expressed by some speakers about the use of Order 2, others considered that it appeared to have practical value. One speaker suggested that special conditions should be expressed at class level, and that Order 2 might be in danger of degrading to a "don't know" grouping. One speaker

proposed that suitable-unsuitable should be split at class level. Another speaker reported that a framework including the three Orders worked satisfactorily in different places where it was tested, but that the use of Order 2 should be limited to land evaluation in which major improvements are specified (i.e. not to be used in "actual" suitability classification).

It was suggested that an uncommonly high quality of management could make otherwise unsuitable land suitable, for example for irrigation farming. This could be handled either within the land utilization type (high level of management) or in Order 2 (suitable on condition that farmers with high level of experience are present).

Land unsuitable for the general use of the area but suited for special crops (steep land suitable for fruit trees,for example) could be shown by comparing a classification for the general use with a parallel one for fruit, but more conveniently by use of Order 2 (suitable on condition that crop choice is restricted to fruit trees). Such a classification could be shown as 2.2F, for example, where 2. is conditionally suitable; .2 moderately suitable; and F indicates the nature of the special condition, the latter similar to a classification in use at present.

It was recognized that the user of land evaluation data would run into difficulties if presented with a large number of parallel classifications for different land utilization types. In Iran this problem was minimized by presentation of data in tabular form. Also, the data become much simpler to use if the number of land utilization types is limited by the use of Order 2 to indicate special conditions for suitability of certain areas.

The term "conditionally" was discussed, one speaker mentioning possible danger of confusion with the USBR conditional class. The suggested replacement "partially" only covers part of the concept "conditionally", however.

It was stressed that for an important group of users of land evaluation data it is especially important that data should show full cost: Planners are concerned with judgement of alternative uses of money, regardless of what proportion of this cost, if any, the farmers would repay. Use of a realistic discount rate in quantitative evaluation would therefore be essential.

On the question what to do with a unit of land "poorly suitable" (for irrigated agriculture, for example) which upon quantitative evaluation turns out to be "unsuitable", reclassification of the land unit was proposed. Such difficulties are avoided in part by the approach of the US Bureau of Reclamation, in which the selection of land is a two-step process: first, selection of an "arable" area

as guided by farm production economics and second, selection of an "irrigable" area as guided by the economics of plan formulation. The application of plan formulation criteria to the classification generally leads to successive elimination of identifiable increments of arable land from the development plan. Typical adjustments include elimination of non-economic increments such as those that are too costly to provide irrigation water; drain; or provide distribution access. This method is comparable to land evaluation in stages (Background Document, section 2, p.59).

The distinction between correctable[+)] and uncorrectable (permanent) limitations, which is essential to planners, could be shown by parallel land suitability classifications with and without specified major improvements if the correctable limitation affects considerable parts of the area; or by the use of the Conditionally Suitable Order 2 for small parts of the area; or, as suggested by a speaker, in the subclass designation.

A brief discussion followed on the difficulties associated with land patterns that give rise to complexes of different land suitabilities, or with utilization types that call for the combined use of different kinds of land (complementary uses).

It was questioned whether a global classification of land was planned and, if so, how the necessary international exchange of land evaluation data was to be approached. This would be practical and possible if physical factors were considered for specified broad uses and within a broad, socio-economic context only. That physical step of the land evaluation process could efficiently be used to exchange and compare information between regions and countries. More advanced steps in land evaluation, with more socio-economic data entering the suitability classification, would be much less practical and perhaps useless for international exchange of land evaluation data or for the preparation of a classification covering the world.

VIII. ENVIRONMENTAL CONSIDERATIONS

Professor Bennema briefly introduced the topic by pointing out the important influence which selection of appropriate land utilization types could have on the control of environmental deterioration. He emphasized that deterioration may take many forms. Even in the field of soils there is much more to consider than

+) by major improvements

erosion - loss of organic matter and depletion of nutrient status, for example. In the environment as a whole many other factors such as the build up of pests or deterioration of the microclimate may be associated with unwise choice or association of land utilization types. Resistance to specific aspects of deterioration might be regarded as important qualities of the land.

Before opening the topic to general discussion professor Bennema called upon Mr. P.Mahler to express his views in the light of his close association with the preparations for, and follow-up to the recent UN Conference on the Human Environment in Stockholm.

Mr.Mahler considered that concern for environmental quality should permeate the whole land classification process. He felt that consciously evaluating "land" rather than "soil" was bound to assist this aim, as would a concept of "suitability" based on a requirement for sustained use. The land management requirements to be proposed must include those practices needed to maintain or increase productive capacity over the years. If some degree of land deterioration appears to be unavoidably associated with an otherwise desirable land utilization type this might be a case for classification in Order 2 - suitable on condition that a certain degree of deterioration was acceptable. An asterisk or some other suitable symbol in the map legend might serve to draw attention to uses which represented a particular hazard to the environment. Interaction between adjacent lands was a matter for special consideration. A land quality that could have special environmental significance might be "carrying capacity for waste".

In the general discussion that followed it was agreed that there were circumstances in which a certain degree of degradation was inevitable. The internal transmigrations in Brazil were cited as an example where exploitation of the most fertile soils by primitive means is bound to lead to a lowering of production. Where such exploitation can be controlled but not eliminated it must be kept within acceptable limits.

It was stressed that environmental considerations demand a multi-disciplinary approach; indeed that environmental control was a natural fall-out of such an approach. In this context the Background Document of the Consultation was criticized on the grounds that it paid only lip service to its avowed interest in a multi-disciplinary approach. In many places it gave indications of being a document prepared by soil specialists for soil specialists - an impression heightened by the preponderance of such specialists at the Consultation. Thus a credibility gap opens as to whether it really is "land" that is being considered. The Glos-

sary, for example, should include definitions of such terms as sustained production, or yield, and multiple use, for these terms are used differently in different scientific disciplines.

Stress was placed on the need to steer a middle course between a purely developmental approach and one concerned solely with environmental impact. It was suggested that a statement on environmental impact, if it is not included in the described classification of individual land utilization types, appear at least as an appendix to an evaluation report. Furthermore the resource surveyor should be called upon to make relevant recommendations in the design stage of development.

It was reported that an environmental impact statement was now required in any submission to the IBRD (World Bank). The World Bank, in turns, tries to include remedies for such hazards as health dangers associated with irrigation, or downstream effects of irrigation and drainage projects, without influencing its assesment of the financial viability of the project.

Since it was scarcely possible to develop a satisfactory environmental impact statement for all conceivable land utilization types in an area, a speaker suggested that this task would be better postponed until some development decisions had been taken at the land use planning stage.

Another speaker drew attention to the lack of adequate criteria for establishing acceptable levels of some aspects of degradation, including the level of chemical contamination of soils and water. In the same context, attention was drawn to the very serious contamination sometimes associated with mining and industry. It was suggested that land utilization types involving mining should be identified, and that special attention should be paid to the qualities and use of land above aquifers.

The importance of ensuring the broadest possible base for the evaluation framework was stressed - as far as possible to meet the needs of everyone and to foresee all environmental consequences associated with each use and management. In planning inputs special attention should be paid to control of environmental nuisance. In a related context, it was recognized that the pursuit of agriculture often entailed accepting a compromise between conservation and degradation. A responsibility must also be accepted to ensure in evaluation that all land utilization types should include all measures necessary at the highest practical intensity to minimize nuisance in the long run.

This implied, another speaker added, that land utilization types must not only be

"relevant" but also "justified". Furthermore, they must be justified in a very broad setting; coastal horticultural projects, for example, must be justified in terms of possible damage they might cause to coastal fisheries.

At the same time, the aims of land evaluation must be kept within reasonable limits. A speaker enquired whether it would be considered within the terms of reference of the proposed framework to investigate the influence of irrigation projects on downstream salinity, possibly in another country. Such an investigation is currently in progress on the Colorado river in USA. It was thought that while some problems lay centrally within the terms of reference of land evaluation, the process could only contribute marginally to the solution of other problems.

Discussion followed on the exact interpretation of the phrase "rural purposes" as this was used in the title of the Consultation.[+)] It was agreed that although rural areas embrace very nearly all forms of land use, discussion could most usefully be confined to agriculture in its broadest sense (including forestry and animal husbandry) together with engineering interests directly associated with agriculture, and with recreation, wildlife and "non-use". In Canada, it was reported that five land classifications (agriculture, forestry, wildlife ungulates, wildlife waterfowl and outdoor recreation) were undertaken. In conjunction with the soils map these generally provided sufficient data for planning such non-agricultural uses as urban and industrial development.

IX. THE OVERALL APPROACH TO LAND EVALUATION

In his introduction, Mr.K.J.Beek summarized the series of steps listed in section 9.2 of the Background Document into five major stages: Preparation (steps i and ii); survey and investigation (steps iii and iv); qualitative interpretation (steps v to xi); field check (step xii); and quantitative interpretation (step xiii). These are not separate, succeeding steps or stages: in practice there is considerable overlap.

The place of the different aspects discussed previously in the overall land evaluation sequence was illustrated by reference to figures reproduced on page Figure 1 (from Beek and Bennema 1972) refers to Background Document steps v to viii; figure 2 (ibid.) shows the overall sequence of steps.

+) See footnote in section 1.1 of Background Document, p.57

Fig.1. FLOW CHART FOR PRESENT SUITABILITY CLASSIFICATION

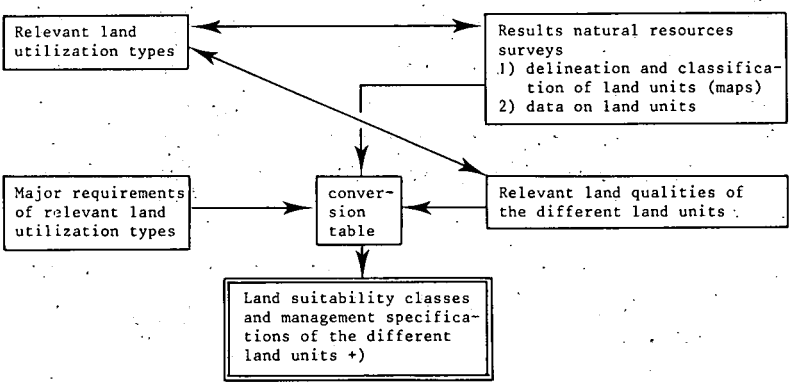
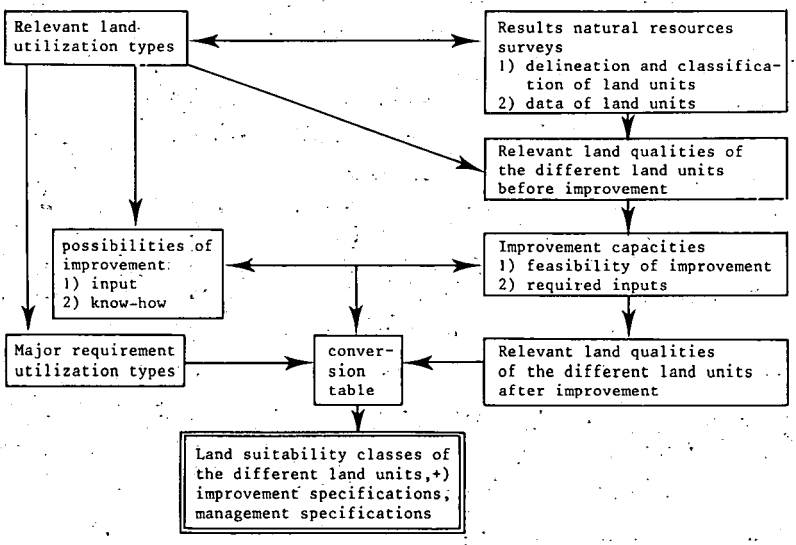


Fig.2. FLOW CHART FOR POTENTIAL SUITABILITY CLASSIFICATION



+) *Land units* in Fig.1 and 2 are *land mapping units*

With reference to parametric methods, Mr.Beek emphasized that quantitative expressions defining a land quality are of great value, and that parametric methods may produce such a function. Gross yield has generally been used as the defined major quality. In some cases, valid only within the socio-economic conditions and environment of a certain area, a short cut is possible, translating land properties directly into quantitative land suitability. For example, where inputs and crop patterns are uniform, gross yield may define suitability.

Questions for possible discussion were:

Have the new concepts been properly introduced into an overall framework?
Would it be possible to introduce them into the different national systems?
Would the new approach assist socio-economic development?

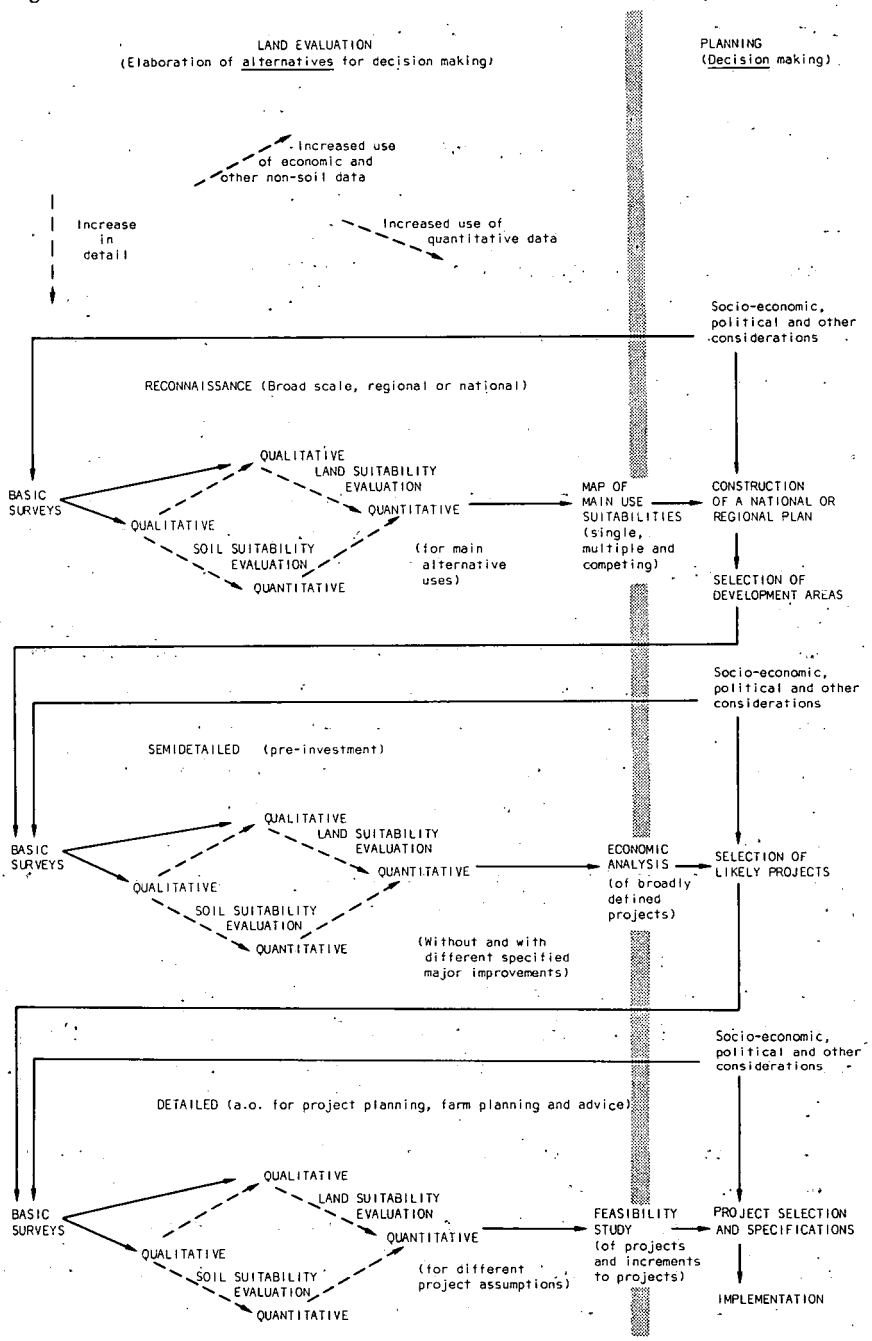
Some general points remaining from previous sessions were next discussed by Mr.R. Brinkman, using a table reproduced on page 49 (Fig.3), indicating three distinct directions in the total land evaluation activity: increase in detail; increase in use of quantitative data; and increase in use of economic and other non-soil data. These points included the place in the land evaluation framework of, for example, present "land capability";soil suitability; "vocation du sol" classification; the check list for basic surveys; the different model methods (Riquier, Sijs, Nix); and the individual land suitability classifications for different uses and their inter-sectoral integration by the Canada Land Inventory, as well as the relation between land evaluation and land planning. International correlation and transfer of data could best be effected using qualitative and quantitative soil suitability classification, in which diagnostic criteria are purely physical and not yet modified by economic considerations or transformed into economic terms.

During the discussion, general agreement was expressed that the concepts presented during the Consultation are usable in practical land evaluation, and that the framework can effectively guide the land evaluation process, also in different industrialized countries.

In the first steps of Background Document section 9.2, "identification of present land use problems" should be included. Present problems are generally a primary reason for land evaluation, and they should be kept in mind throughout.

Land utilization types should only be formulated very broadly or for individual crops in the early stages of evaluation, to be refined as more data become available. With great detail in description including, for example, details of management or optimum percentages of crops, one should avoid making separate land utilization types for each land suitability unit since this would defeat the objectives

Fig.3. CHART OF LAND EVALUATION ACTIVITIES



of clarity and simplicity for the user. Such variations could best be included within one land utilization type but spelled out where known in the management specifications for each land suitability unit.

The concept of land utilization types should be further structured, particularly with regard to (normative) levels of generalization or specification.

Also, the concept of land qualities should be elaborated, with definitions of their relationships to each other and with a structure showing their levels of generalization. For example, produce (gross yield, gross products and benefits) is a quality at a high level of generalization, and may be used either direct, or built up by model methods from land qualities at lower levels of generalization or from single land properties.

One speaker advocated inclusion of a separate step after step ii: the elaboration of a data collection system suitable for computer processing, based on knowledge of the influence of different factors on plant production and of the economic results of plant production. Another speaker suggested this should be an exercise at a later stage, once results available would form a basis for knowledge of such influences.

It was suggested that an overall set of norms would be needed: land evaluation activities and conclusions could then be related to these common norms (possibly in the form of a manual, to be developed and adapted with time).

Land evaluation - land planning is not a one-way connection. Different speakers stressed that there should be a possibility of checking different development plans by evaluation specialists, and that plans should be monitored for their effect on the quality of life and on other uses inside and outside plan boundaries.

Also, planning activities may give rise to a demand for more specific or more sophisticated land evaluations, or evaluations for other uses, not necessarily in greater detail than the evaluations already available. Thus, interdisciplinary land evaluation and intersector land planning could form an alternating sequence in some cases.

The need to use data and work already available was stressed; since one is not evaluating an unknown planet one may enter the land evaluation process at different places, depending upon available data and interpretations.

Speakers remarked that full cost of non-recurrent and recurrent inputs should be specified, since high recurrent inputs needed may be related to correspondingly

low inputs on major improvement, for example.

Speakers from a number of industrial and developing countries indicated that they would be using the framework and concepts elaborated during the Consultation in further modifications of their national land evaluation. Some countries already use an almost completely compatible system.

X. PRESENTATION OF LAND EVALUATION DATA

Dr J.S.Veenenbos in his introduction of the topic explained his intention to confine his remarks to the material presented in section 8.2 of the Background Document. He demonstrated the procedures, developed in the Soil Institute of Iran, for the simultaneous display of actual and potential suitability classifications relating to a number of different land utilization types in a tabular mapping legend. He emphasized the desirability of indicating the level of non-recurrent input associated with each potential suitability classification and showed how this too could be included in the tabular legend. He pointed out that the method requires that land mapping units should be numbered, or otherwise identified, individually. The user may wish to know more than the mere suitability classification, in which case additional map symbols would be needed to reflect the major characteristics or qualities of the land units. Dr Veenenbos invited comment on the desirability of combining maps and/or legends of actual and potential suitability. He also questioned whether it would not be desirable to show subclass as well as class designations for each unit in the legend.

Opening the general discussion, a speaker emphasized that land evaluation was more than a classification of suitability and for this reason a supporting text for evaluation maps was essential - the problem was how much information should be placed on the map rather than in the text? In the speaker's view as much decision-making information as possible should appear on the map and, since it was desirable to support and explain these judgements, the map legend should also include as much information as possible on the basic characteristics or qualities of the individual map units. Another speaker, however, stressed the importance of also producing simple interpretative maps and felt it would rarely be advisable to include land unit characteristics in their legend.

Ministers and other very senior decision makers were seen as a special audience for interpretative material. Very short texts of a few paragraphs and maps depict-

ing essential contrasts would be the only form of presentation likely to attract attention within the busy schedule of such people.

The virtues of simplicity associated with a single factor map were stressed. In this context it was pointed out that a multi-purpose map with tabular legend, if printed in black and white, may be coloured as required to reflect the actual or the potential suitability of the area for any single utilization type, thus enjoying the immediate impact of a single factor map.

Attention was drawn to a reference in the Background Document to the use of tabular, rather than mapped information "if the geographic distribution of the land units concerned is not of prime concern" (section 8.1, first paragraph). This statement, it was thought, reflected a lack of appreciation of the dynamic nature of land data. Even if geographic distribution is not of prime concern at present it may become so once a new balance is established following improvements. This point was agreed but with the explanation that the reference in the Background Document related to statistical studies of nations or large regions (such as FAO's Indicative World Plan) in which land resource data might be important, although the time frame did not permit any systematic mapping.

Mr.Brinkman referred to the appendix of his paper on "Quantitative suitability classification: an example", included in the documentation of the Consultation, for examples of very detailed information that could conceivably be presented on maps but only with great difficulty. In fact, simple class symbols on the maps provide a convenient cross reference to the detailed tabular data.

Referring to the problem of presenting information on complex, heterogeneous land units a speaker suggested that, if it was impractical to subdivide such units, a symbol could be used to indicate that the interpretative classification referred to only part of the unit - in Iran the class symbol was enclosed in brackets in this circumstance.

Indication of classification at the subclass level was particularly useful when both actual and potential suitability classifications were displayed, since a change at subclass level would show which limitation has been removed.

The need to develop ways of explaining and presenting present and future problems of land use was emphasized. Such problems create the need for land evaluation and their understanding should justify the utilization types, improvement and management practices proposed.

Attention was drawn to the ambiguity of the term "unit" in the Background Document. In some contexts the term was derived from "land unit" meaning a specific

tract of land (usually a map unit). Elsewhere it was a contraction of "land suitability unit", the lowest category in the suitability classification. A need for change and definition of this nomenclature in the Glossary was agreed.

Further discussion of the nature of the land unit followed. It was recognized to be essential to distinguish on the one hand the "parcel" of land with specific location and specific geographic boundaries and, on the other, the grouping of soil taxonomic units having only conceptual boundaries. A speaker pointed out that there is a tendency to think of land units as being more extensive than soil units, presumably because the former has the wider range of components. In fact, the reverse may be true since, in many instances, units of land will be identified by subdividing soil units in recognition of significant change in some other land component (possibly vegetation). The desirability of recognizing a need for interpretative classifications of soil and for interpretative classifications of land was reiterated. Very similar principles, similar to those outlined for land in the Background Document, couldd apply to each. However, soil suitability classification would serve the scientist in exchanging information and in interpreting land, while land suitability classification would be the vehicle of communication with the land user.

The similarity between the concept of land unit and that of "ecological station" used in Portugal was again mentioned (see discussions of session II). In practice the "ecological station" is determined by combining the soils map, the land capability (soil limitations) map and the climate map. Suitability for any particular crop is the same at any point within the homogeneous ecological station.

It was pointed out that land mapping units would always have both physiographic and non-physiographic contents and it was suggested that both should be used for delineating boundaries and in drawing up a hierarchical legend. Place in the hierarchy of the legend should be decided by degree of permanence of the criteria, the more permanent the higher in the hierarchy. In general, physiographic attributes have greater permanence than institutional or administrative attributes but this is not always the case (water management districts of the western part of The Netherlands, for example). Although each land unit is to a large extent unique, clearly defined relationships between units should appear in the legend to assist transfer of information from one area to another.

Mention was made of the importance of direct, word-of-mouth communication between interpreter and user recognizing that many users will be unable to make adequate use of either tables or maps. It was also pointed out that this direct communication was a vital part of the "inter-sector approach" particularly between land

evaluators and land-use planners.

In reply to a question, the difference between present land use and "actual land suitability" was explained - the latter relating to all use possibilities without major improvements, including the present use of the land. Present land use might well affect the use possibilities of a tract and so require the subdivision of a soil unit for purposes of land evaluation. One speaker expressed the view that considerations of present land use should not become significant before the land use planning stage.

There was also brief reference to the presentation of laboratory data in evaluation reports. There was agreement that such data should be carefully selected to exclude information that was not strictly necessary (or repetitious) in relation to the purpose of the evaluation. Laboratory data deserved more extensive, though still not excessive, presentation in reports on basic surveys, where it might well point out significant practical problems.

It was reported that the large computer storage and mapping facility of the Canada Land Inventory had very recently become operational. Although initial costs had proved very high, now that the facility was established the cost of input of the large range of data relating to the different aspects studied in the Inventory would only amount to 50 Canadian cents/square mile. It was expected to prove especially useful with regard to problems involving many inter-sectoral variables.

Another speaker stressed the importance of land evaluation in planning wiser distribution of land use within the Common Market countries of Europe faced with an excess of agricultural production. Concentration and intensification of agriculture on the best suited soils would release large areas of land needed for other purposes.

The session closed with a brief discussion on the problems of evaluation and presentation that would arise if very large numbers of land evaluation types had to be recognised. While it was difficult to indicate the number of utilization types needed in a given circumstance this number need not be very large. The key attributes were broad in concept and a number of minor differences in use could be combined in a rotation considered within the individual land utilization type although, of course, the suitability of the land for each crop would have to be assessed. Moreover, use of the "Conditionally suitable" order could further reduce the number of land utilization types.

MAIN TEXT OF BACKGROUND DOCUMENT

This chapter comprises the main text of the Background Document as used during the Consultation. Some improvements and clarifications suggested before and during the Consultation have been included as numbered footnotes marked +) to distinguish them from those originally present.

The appendices summarizing some existing methods of land evaluation have not been reproduced here.

Purpose and origin of the Background Document

The sole purpose of this document is to assist an Expert Consultation on Land Evaluation scheduled to be held in The Netherlands in October 1972. It is intended for circulation in advance of the meeting, only to those expected to participate directly or indirectly in the work.

The document is intended to clarify the scope and purpose of the discussions - to provide specific proposals for standardization of methodology of land evaluation, which will serve as a focus for both written contributions and discussions - to provide a glossary of defined terminology for use, where possible, in these contributions - and to provide orientative information on existing systems as a background for discussions.

The proposals are offered to stimulate ideas and to highlight problems relating to separate aspects of evaluation. While proposals relating to different aspects are believed to be compatible, the document does not attempt logical presentation of a complete system of evaluation. By dividing the subject matter it is hoped to facilitate discussion under separate agenda items and also to encourage participants to put forward specific proposals. The sequence of topics is planned to allow new ideas to be introduced and their significance explored in successive stages of discussions. Thus, "Overall approach" and "Presentation" are the last topics to be discussed. It is hoped that these discussions will provide a foundation upon which a comprehensive framework for land evaluation can be developed.

A framework intended to meet the interpretative needs of the widest possible range of rural land surveys is inevitably complex but it is emphasized that not all of the proposed procedures need be employed in any one survey.

The document has been prepared jointly by two technical working parties, one in The Netherlands and the other in FAO, Rome, assisted through correspondence by the Consultants and other specialists in land evaluation.

1. INTRODUCTION

1.1 The objectives of the Consultation

The Consultation provides an international forum for discussion of specific proposals for the standardization of methodology and terminology in land evaluation for rural[1)] land use.

The methodology of multidisciplinary land evaluation which it is planned to develop is intended to serve as a universally applicable and widely acceptable framework within which adequate systems of land appraisal appropriate to local conditions could be constructed. The new methodology should be based on experience in the use of existing evaluation systems and should incorporate, insofar as possible, all that has proved valuable in these systems.

Greater standardization in interpretative approach and presentation is needed to improve understanding and two-way communication between persons and organizations engaged in land resource survey including interpretation and the users of land evaluation data. These users include persons, organizations and investment agencies responsible for planning, financing, executing, operating, and administrating rural development, readjustment, agrarian reform, research and environmental management programmes.

The standard framework must secure a clear and simple, yet sufficiently precise representation of the evaluation for the user. Standardization will assist users to familiarize themselves with different systems employed in varied conditions, for all will have a common base. Interpreters will be able to pool experience and knowledge expressed within the framework more readily and reliably, leading to refinement of interpretations and improvement of the framework itself.

Against this background it is hoped that the deliberations will lead to:

a) agreement upon basic principles, required structure and basis of presentation of a standard framework for land evaluation

b) on outlined basis for the use of specific environmental criteria, which singly or in combination require to be considered in land evaluation

c) agreement upon definitions of terminology for use in this work

d) a stage of agreement on a general evaluation method, or methods, that will permit testing and, possibly, application in the field.

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1) As opposed to urban or industrial. Rural engineering works having no direct bearing on agriculture (in the broad sense) are also excluded at present, e.g. highway and airfield construction.

Emphasis will be given to the general approach but, hopefully, required methods and terminology will be developed to a point at which they will provide the required framework for adequate, locally adapted land evaluation systems. A planned set of examples, together with explanatory guidelines, should contribute to the development of such systems.

1.2 The scope of the discussions

In keeping with the specialized experience of the majority of its contributors, the Consultation will concentrate its discussions on assessment of the physical and technical suitability of land for uses judged to be relevant in rather broad social and economic terms.

Thus the discussions will centre upon development of a standard framework for interpretation schemes that will indicate present and potential suitability of identified unit of land for alternative uses in both qualitative and simple quantitative terms[1]. The discussions will also include:

a) identification of the nature of criteria and basic data required for land suitability interpretation

b) identification and preliminary evaluation of input requirements associated with alternative uses.

Aspects of the overall procedure of land appraisal which will not be discussed in detail include:

a) methodology of basic data collection - although it will be necessary to consider whether endorsed procedures are practical in relation to the possibilities of data collection

b) sophisticated methods of economic analysis or of social study required in later stages of the land evaluation process - although, again, it will be necessary to consider whether the proposed classifications have the necessary capacity for such refinement

c) final stages of land appraisal involving classification in terms of programme effectuation and reflecting final decisions on the implementation of projects.

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1) What are here termed *qualitative* suitability ratings are based on some, often very simple, cost-benefit suppositions. They lack, however, the numerical economic distinctions implied in this document by the adjective *quantitative* - see Section 5.2.1, p.69

The following specific topics are included in the agenda and are discussed in later sections of this document:

a) identification of the subject matter of land evaluation
b) land suitability classifications
c) evaluation of required inputs
d) diagnostic procedures and criteria
e) principles of presentation
f) the overall approach to land suitability classification.

The role of land suitability classification in the overall process of land appraisal and the basic requirements of a standard interpretative framework - considerations which further define the scope of discussions - are described in Sections 2 and 3.

2. THE ROLE OF LAND EVALUATION IN THE DEVELOPMENT PROCESS

The planning of land development and readjustment is usually carried out in a number of successive phases (e.g. national resources survey, project identification, feasibility study and implementation planning). Within each phase three stages of study may be undertaken, all based upon basic inventory of land characteristics:

i) land evaluation; involving interpretation of basic data to provide ratings of relative suitability of the few socially and economically promising, physically possible land-use alternatives

ii) socio-economic analysis of a very limited number of recommended use alternatives (perhaps only one)[+] to establish their economic and social desirability, investment feasibility, etc., on a particular site but within the context of a survey area, region, nation or even larger area

iii) classification for programme effectuation; reflecting final decisions on implementation of projects.

Each of these stages must be designed to meet the requirements of the next. Some overlap in the conduct of consecutive stages is usual and desirable.

In stages (i) and (ii) there may be need to distinguish interpretations relating to present and potential conditions of the land - i.e. with and without major improvements where necessary.

[+] delete *(perhaps only one)*. Normally, alternatives are needed.

Stage (i) "land evaluation" includes both qualitative and quantitative suitability classifications. Quantitative classification is usually essential if an objective measure of the relative suitability of land-use alternatives is required. The precision of quantification required depends upon the immediate purpose of the study and thus upon the stage in the development process at which the evaluation is undertaken. No precise dividing line can be drawn between quantified "land evaluation" and the more sophisticated economic and social studies of stage (ii). However, as a guideline for the Consultation, which is directly concerned only with stage (i), it may be stated that the assessments undertaken in this first stage are:

a) confined to the simplest concepts of land development cost in relation to production benefit sufficient to provide a reasonably reliable estimate of profitability based on parameters which are likely to be of a provisional nature

b) developed, as far as possible, within the context of the particular land unit (i.e. not taking detailed account of such factors as location in relation to markets, influence of production on neighbouring units, or socio-political considerations)

c) undertaken prior to, and to provide a basis for, discarding use possibilities that can be seen to be unattractive when compared in simple economic terms.

A sound land evaluation should contribute the answers to the following questions:

a) What[+)] will happen in the future if present use practices remain unchanged?

b) What other uses of the land are possible under the relevant social and economic conditions?

c) Which of these uses of the land offer possibilities of sustained productivity and/or services, and environmental quality?

d) What limitations and/or adverse effects are associated with each alternative?

e) What recurring inputs are necessary to minimize limitations and adverse effects?

f) What are the benefits of each use?

+) replace *What* by *How is the land currently used and managed, and what*

If major changes (change in land use or change in management system) are envisaged, the following questions also have to be answered:

g) What changes in the condition of the land are necessary? How are they to be effectuated?

h) What are the major non-recurrent inputs necessary to implement these changes?

i) What recurrent inputs will be necessary once the major changes have been made?

j) What is the nature and magnitude of benefits to be derived from all of these inputs?

3. BASIC REQUIREMENTS OF A STANDARDIZED APPROACH TO LAND EVALUATION

The envisaged standard framework and the systems to which it gives rise should:

a) be readily and reliably understandable to the user. Presentation should be simple[+)] and adapted to the purpose immediately in view. All technical complexities should be problems for the surveyor/interpreters, not for the user

b) have global application. This implies a framework with capacity to accommodate interpretations relating to alternative kinds of present and potential rural land use, to different possible levels of management (systems of land utilization), to different intensities and methods of survey and to the whole range of ecological conditions

c) be flexible, permitting adaptation to local circumstances. Within the framework it should be possible to accommodate additional, more detailed, groupings and interpretations designed to meet local needs without distortion of the basic concepts

d) permit interpretation in stages. For a given locality the defined interpretative land classes should be fully convertible in quantitative (economic) values. The degree and reliability of quantitative support for the interpretative classifications must be clearly indicated to the user

+) It was stated that misleading oversimplification should be avoided. The classification for users should be a synthesis of information, while the full information in all its complexity should remain available for study or future re-examination in the form of supplementary reports or archive-stored data.

e) favour periodic adaptation and correction as required by the development of new means of production and by changes in the level of capital and recurrent investment in agricultural and forestry production

f) be designed for implementation by a team of specialists, possibly involving different specialists for different periods at successive levels of quantification. The range of expertise involved in land appraisal for almost any purpose is greater than a single specialist, or field of specialization, can cover. To be of lasting value the reliability of all aspects of the interpretations derived must inspire the confidence of investment institutions and other users.

4. IDENTIFYING THE SUBJECT MATTER OF LAND EVALUATION

4.1 Basic concepts and requirements

The most important aim of land evaluation for rural land use is to serve as a tool in land development, which, besides agricultural development, should also take into account useful services, e.g. for recreation, for wildlife, and for watershed protection. For a given parcel of land, development might include a change in major land use, a change in management systems within a given land use or only minor changes in management practices within the actual management system. The land evaluation has to give indications about desirable changes in land use or management systems and about their economic implications[+]. Desirable minor changes in management practices within a given management system are not necessarily considered in land evaluation but evaluations based on high intensity surveys can be expanded to include advice on desirable minor changes.

It is recognized that each area of land is likely to be suitable to varying degrees for more than one kind of rural use and that all relevant forms of rural use should be appraised separately, their relevance being determined by the socio-economic conditions of the area.

To have global application a standard evaluation framework would require to have capacity to accommodate interpretations relating not only to alternative kinds of present and potential rural land use and to different possible levels of management (systems of land utilization), but also to different intensities and methods of survey and to the whole range of ecological conditions.

[+] It was agreed that land evaluation should be done by a multi-disciplinary team including the appropriate specialists.

To ensure that the significance of each evaluation is correctly understood, all significant assumptions relating to the purpose of the use concerned and to the nature and level of management to be employed must be clearly defined. The detail of each aspect of these definitions should be compatible with the intensity and reliability of basic data collection, with the purpose of the interpretation and, consequently, with the stage in the development process at which the interpretation is undertaken.

4.2 Proposals

4.2.1 The concepts of land, soil, and land suitability

(i) Land

It is proposed that the term "land", subject matter of the planned evaluation procedures, be defined as follows:

"A tract of land is defined geographically as a specific area of the earth's surface: its characteristics embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area including those of the atmosphere, the soil and underlying geology, the topography, the hydrology, the plant and animal populations and the results of past and present human activity, to the extent that these attributes exert a significant influence on present and future uses of the land by man".

(Adapted from Christian, 1963, as quoted in Christian and Stewart, 1968: "Methodology of Integrated Surveys", Proceedings of the UNESCO Conference on Aerial Surveys and Integrated Studies, Toulouse, 1964.)

NOTES

a) As defined, the term "land" embraces all but the purely socio-economic (human) attributes of the environment. It is assumed that all approaches to interpretative land classification would, to a varying extent, take additional socio-economic factors into account but these are not considered to be attributes of the land itself.

b) Land is a broader concept than soil. Thus, in developing interpretative land classifications from soil survey data, additional aspects of the natural environment, notably macro-topography, vegetation, surface and ground-water hydrology, and climate as well as certain stable man-made features, need investigation and integral interpretation.

c) The range of indirectly related attributes of land is very great. Thus, individual tracts of land defined in terms of specific combined expressions of these attributes tend to be unique. In practical interpretation work, a substantial amount of correlation between land tracts is usually possible, however, since the individual criteria on which interpretative land classification is based are mostly correlatable.

(ii) Soil

In the past, much confusion has resulted from a lack of clear distinction between the terms "soil" and "land" - particularly in the context of land classification. The following definition of a body of soil, as the latter is understood and mapped by a soil surveyor, is offered to clarify further the present proposal:

"A soil is a three-dimensional body occupying the uppermost part of the earth's crust and having properties differing from the underlying rock material as a result of interactions between climate, living organisms (including human activity), parent material and relief over periods of time and which is distinguished from other "soils" in terms of differences in internal characteristics and/or in terms of the gradient, slope-complexity, micro-topography, stoniness and rockiness of its surface."

(Adapted and developed from U.S. Soil Survey Staff, 1960: "Soil Classification 7th Approximation", USDA, Washington.)

NOTES

a) The concept of soil as mapped in soil survey, although narrower than that of land, embraces many surface as well as sub-surface characteristics. In a brief definition prepared in the context of land appraisal it is considered more important to enumerate these surface attributes than to attempt more precise definitions of the lower limit of soil in a deep regolith.

b) The various aspects of climate within the soil (soil climate) are included amongst "internal characteristics" which distinguish one soil from another. Climate above the soil is clearly not an attribute of soil but is often taken into account, nevertheless, in soil classification (interpretative or otherwise).

(iii) Land suitability

Land suitability is the fitness of a given tract of land for a defined use. Differences in the degree of suitability are determined by the relationship, actual or anticipated, between benefits and required inputs associated with the use on the tract in question.

4.2.2 Identification of "land utilization types" [1)]

Since land suitability to a large extent depends on the purpose which the land is required to serve, it is proposed that relevant use possibilities (land utilization types[+)] or development alternatives) should be identified at a very early stage in the land evaluation procedure and should, therefore, serve as the subject matter of separate interpretative classifications. Each evaluation as such would be considered independently and without reference to the desirability of other relevant uses of the same land. A given use possibility may be relevant only in parts of the area studied and would only be investigated there.

Only the most promising development alternatives would be selected for interpretation. The surveyor would require guidance in this choice before basic survey starts; he would perhaps identify further possibilities during the survey. An excessive range of interpretations must be avoided since it would confuse the user.

The degree of refinement of the definition of land utilization types should be compatible with the objectives and intensity of the study and the availability of reliable data on ecological environment and management response. Extrapolation and transfer by analogy may help in assessing suitability of rather unknown areas, but such data cannot replace the need for local research.

Depending on the phase of the development planning process and the corresponding intensity of the study, separate alternatives could represent broad differences in agricultural use (irrigated arable farming; rainfed arable farming; rangeland, etc.); specific aspects of such use (e.g. gravity irrigation; sprinkler irrigation); or even specific crops. Here only the essential distinguishing factors are dealt with, which have a marked influence on the productive capacity of the land. The following factors are important, most of which can be quantified per unit area:

a) Produce
b) Capital intensity
c) Labour intensity (man months/ha)
d) Farm power (source of power and HP/ha)
e) Level of technical know-how
f) Farm size
g) Land tenure.

Sometimes other factors, such as the status of infrastructure, are variables of dominant importance.

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1) Based largely on Beek 1971, unpublished report

+) The term *land utilization system* might be useful at a high level of generalization.

Produce is definitely the most diversified and important factor. In its widest sense not only primary biological production is included (pasture, crop, forest), but also secondary production (livestock, wildlife)[1], as well as other alternative types of land utilization such as outdoor recreation. The produce to a great extent determine the importance of the other factors pertinent for a land utilization type.

Sometimes different types of produce represent a single land utilization type (mixed farming models, crop rotations). Evaluation should then be undertaken for the land utilization type as a whole, which gives a better picture than a separate evaluation for each produce component. However, for reasons of comparison it will be advisable to compile the suitability for the land utilization type on the basis of the suitabilities for the suitabilities for the individual components.

Capital intensity[2] determines possibilities for improvements, maintenance and conservation of the land conditions.

Technically it would be possible to condition virtually any given site to satisfy a particular need or requirement. However, the extent to which this occurs in practice depends on the inherent characteristics of the land conditions, the cost of modifying them in relation to the value of the desired product, and the availability of private and public capital.

A distinction must be made between:

- non-recurring (capital[+]) input requirements or development cost
- recurring production inputs (including operation and maintenance where relevant).

Within each (biological) production process, several input levels can be distinguished. Only a few levels are suggested. Several land evaluation studies distinguish at least two levels: low (traditional, present land utilization type) and high (advanced, modern, potential land utilization type).

For crop production, four or five input levels may be of interest. Of course, very

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1) A comment on the preliminary draft points out that animal production requires special consideration in that animals may be fed from imported feedstuffs and are not necessarily directly dependent on the local qualities of the land.

2) Alternatively, *input intensity*, recognizing that the availability of some inputs, notably water for irrigation, is not necessarily governed by capital availability.

+) add *generally*

low/low/medium/high capital inputs would relate to specific types of crop production. Inputs per surface unit for grazing and forestry are generally of a different order of magnitude from those for crop production.

Labour intensity is a variable influenced by the level of applied capital and technology[+)], and by the labour requirements of the produce concerned. Since employment opportunities are a major issue of most development policies, this factor would need to be taken into consideration when alternative land utilization types are formulated, both in terms of permanent and seasonal employment.

Variable degrees of capital/labour intensity also influence the recommended execution of initial special site-conditioning works.

The source of farm power to a great extent determines the accompanying set of agricultural implements, and the level of capital inputs on the farm. The set of implements, in turn, determines a combination of possible farm management practices significant for the land utilization type. The performance of each set of agricultural implements is affected differently by the agricultural land conditions. Important distinctions are:

- engine-power operated machinery
- animal power
- manpower

The level of technical know-how of the farmer is an[++)] important data for the definition of the land utilization type. A major task of the multi-disciplinary land use planning team would be to visualize harmonious land utilization types embracing farming, land management and land improvement practices within the ability of a majority of the farmers and ranchers concerned.

It is often the relatively low level of technical know-how of the local farmer which limits the practical possibilities of potentially ambitious land and water development schemes to solutions at only an intermediate level of technology and efficiency with a restricted range of crops, less sophisticated farm machinery and a restricted input level.'

Farm size is an important factor in the definition of land utilization types. It is closely related to most of the other factors. In certain cases it is determined in advance entirely on the basis of socio-economic considerations without reference to physical conditions. In the planning process, it would be desirable

[+)] population density, rural-urban relationships, dynamics of migration and resettlement would also need to be taken into account

[++)] replace *is an* by *and his degree of willingness to change are*

to recognize farm size as a major variable within a certain range to be determined with increasing precision during each phase of land-use planning and finally established at an optimal level, in harmony with the other elements defining the land utilization type during the economic land classification.

The land tenure system may be an important factor in determining and defining appropriate land utilization types. The existence of some legal, customary or otherwise institutionalized relationship between government, society, groups and individuals, may limit development alternatives, through rigidity of ownership rights and associated duties having important social, as well as production, relationships.

Criteria for defining separate land utilization types need to be agreed upon. The feasibility of identifying a range of possible systems on a global basis should be investigated. It is recommended that the Expert Consultation recognizes the essential elements which characterize land utilization types and expresses an opinion on the classification of these elements, if possible through groupings which represent several levels of generalization. It should be noted that the concept of "level of management" is included within the proposed concept of land utilization type.

5. LAND SUITABILITY CLASSIFICATIONS

5.1 Basic concepts and requirements

The range of interpretative classifications included with a standard framework for land evaluation would be required to:

a) provide a basis for evaluating identified land units in relation to foreseeable forms of rural land use with and without improvements

b) provide possibilities for developing land evaluation in qualitative and quantitative stages depending on the immediate purpose of the evaluation and upon the availability of reliable quantitative data; qualitative and quantitative stages should be clearly distinguished.

At the same time the interpretative categories which compose the interpretative classifications would be required to:

a) be appropriate in their definition for application to each foreseeable form of rural land use

b) express interpretative meaning as simply, as clearly, and as unambiguously as possible

c) include provision for interpretations at various levels of detail depending on survey purpose and availability of information

d) provide flexibility for local adaptation and elaboration to meet local interpretation needs

e) be conceived in terms of clearly defined principles which would serve as a basis for defining individual classes and other groupings.

5.2 Proposals

5.2.1 Proposed range of classifications

It is proposed that the standard framework should provide for a range of interpretative classifications to meet varied survey requirements and circumstances. The separate classifications would frequently represent successive stages in an interpretative study. Each would be an appraisal and grouping of land units to reflect relative suitability for sustained use in a defined manner and for a defined purpose. Thus the land would be evaluated separately in each classification for each relevant land utilization type.

The requirement of separate evaluation of each land utilization type does not prohibit parallel listing of suitabilities for different uses: e.g. to show that individual land units are suitable, perhaps in varying degree, for a wide range of uses. It should be noted, however, that a given class of suitability (e.g.1.2) may have different economic significance when applied to different land utilization types. Consequently, a parallel listing is of no assistance in establishing use priorities unless all of the evaluations listed, at least, have a common quantitative basis for class distinction in economic terms.

Three kinds of suitability classification are proposed with provision for each to be expressed in either qualitative or quantitative terms.

The three kinds of suitability classifications are:

(i) Actual suitability classification

Relates the suitability of land units for the use in question[+)] in their present condition (i.e. without major improvements); suitability being assessed in terms of expected benefits in relation to required recurrent and minor capital expenditure

[+)] may be different contemplated uses: not only actual use. *Actual* refers to the land conditions, not to the use. The contemplated use may include minor improvements, and may be possible only after an agricultural extension effort

(ii) Potential suitability classification
(without amortization of major capital inputs)

Relates the suitability of land units for the use in question at some future date after major improvements have been effected where necessary; suitability being assessed in terms of expected future benefits in relation to future recurrent and minor capital expenditure but excluding consideration of repayment costs on major capital expenditure

(iii) Potential suitability classification
(with amortization of major capital inputs)

The same as (ii) but including consideration of repayment costs on identified aspects of major capital expenditure.

Thus, implementation of major improvements distinguishes actual from potential suitability classifications. In this context, a "major improvement" is a substantial capital, as opposed to recurrent, investment+) in land improvement that will effect a major and reasonably permanent change in the characteristics of that land. Major improvements include the introduction of irrigation; primary reclamation of saline, alkaline and water-logged land and other major drainage works; and very significant alterations to the soil profile by sub-soiling, dynamiting, land shaping or terracing. On the other hand, improved use of existing irrigation and drainage systems, periodic leaching, use of fertilizers or improved seed, cultivation to depths that are usual for the land utilization type in question, minor land levelling and other practices calling for recurrent or minor capital expenditure, are not regarded as "major improvements". Similarly excluded are relatively minor items of capital expenditure relating, for example, to the installation of storage facilities or to the purchase of tractors and implements.

A classification of major improvements (see Section 6.2.2) is needed to link the three kinds of suitability classification by indicating the nature and magnitude of locally required major inputs.

As indicated previously, each suitability classification may be presented in either qualitative or quantitative forms depending on the basis of definition of the interpretative groupings. A classification will only be described as quantitative if the distinctions between its interpretative groupings are defined in numerical economic terms which permit objective comparison with similar groupings

+) replace *capital, as opposed to recurrent, investment* by *non-recurrent input (generally, but not always, a capital investment)*

relating to other utilization types. An interpretative classification will be assumed to be qualitative unless it is stated to be quantitative, e.g. "quantitative classification of actual suitability for horticulture".

5.2.2 Proposed structure of interpretative groupings

It is proposed that the same structure of interpretative groupings be used in all of the interpretative classifications, each class retaining its basic meaning of suitability in relative terms within the context of the different classifications and in relation to each land utilization type.

It is further proposed that four categories of generalization be recognized in each of the suitability classifications. In order of decreasing generalization, these categories are: Land Suitability Orders, Land Suitability Classes, Land Suitability Subclasses and Land Suitability Units.

Only at the highest level of generalization, the Land Suitability Order, would the structure of the classification be rigidly defined. Three Orders of land suitability are proposed:

Order 1	Suitable
Order 2	Conditionally suitable
Order 3	Unsuitable

The purpose of classification at the Order level would be to minimize the risk of misunderstanding by establishing the basic meaning of more precise interpretations. The Order classification would always be quoted in the classification symbol, therefore, even if only one Order of land is represented in the survey area.

NOTE: Order 2 is intended to be used as little as possible and for small parts of the land to be classified. Wherever a large part of the area to be classified requires a certain condition to be satisfied for a specific use, a separate land utilization type should be defined with the condition specified in the management or improvement specifications. Order 2 has been included in this proposal to simplify presentation of the data wherever special conditions in minor parts would otherwise necessitate another evaluation and map for the whole area.

Land suitability classes would be subdivisions of the Orders. In a given study, the number of classes recognized in any Order for each evaluation is left to the discretion of the local interpreter[+)]. The number of classes in each Order would

[+)] suggested addition *but should be limited to the minimum practical number.* Different participants suggested 5 would be the limit for practical use

be chosen to provide the most practical evaluation commensurate with the data available for each land utilization type[1]. A decimal notation (1.1; 1.2; 1.3; 2.1; 3.1; etc.), could be used to denote the separate classes within Orders.

Within each Order the classes serve to distinguish degrees of suitability for the particular land utilization type. The classes would be numbered consecutively in order of increasing limitations, that is to say decreasing suitability for the particular utilization type. Classes would need to be appropriately defined and named to convey their relative suitability. Subdivison of Order 1 (Suitable) into three land suitability classes (Highly suitable, Moderately suitable, Marginally[+] suitable) is recommended[2] if the data available permits.

In a given interpretation the classes of Order 2 (Conditionally suitable) should be precisely similar in their assessment of net benefit as those of Order 1 (Suitable), with the additional understanding that this benefit will only be attainable under conditions which are defined at the subclass level. Consequently, the number of classes in Order 2 must be potentially the same as in Order 1, although it is unlikely that all will be represented in a single survey.

Since land within Order 3 is unsuitable by definition, the decreasing suitability reflected by classes in the Order may be equated with the degree of permanence of the controlling limitations. Thus classes in this Order should be numbered in consecutive sequence of decreasing likelihood that the land concerned would become suitable through improvement or change in socio-economic circumstances. A two class subdivision of Order 3 would frequently be appropriate[++]. Class 3.1 (Presently unsuitable) would relate to land that for practical or economic reasons was unsuitable for the defined use within the time scale of the interpretation but which conceivably could have application for the use in the future. Land placed in Class 3.2 (Unsuitable) would offer no such promise.

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1) In practice it will be desirable to standardize as far as possible the number of classes recognized in different interpretations (for different land utilization types) of a single survey, or in a group of surveys in related areas, since avoidable variation in the number of classes will serve only to confuse the user.

2) even in areas where no land of the first or second degree of suitability for the particular land utilization type has been mapped +++)

+) or *poorly*

++) Different participants suggested Order 3 should comprise only one class, in which the kind of main limitation would be indicated by subclass symbols

+++) Text in brackets added: *(but where such land is known or assumed to occur elsewhere in the country or region)*

Land suitability subclasses are divisions within classes distinguished by the nature of the limitation(s) which has (have) determined their classification. Lower case letters (e.g. w - adverse conditions of wetness, t - adverse topography) following the class symbol (e.g. 1.2w, 1.3t, 1.3wt, etc.), would distinguish the subclasses and denote the nature of the main limitation(s). The limiting criteria (land qualities) chosen to distinguish subclasses, the number of subclasses recognized and the choice of letters to denote limitations would be left largely to the discretion of individual interpreters. However, the following guidelines are suggested:

(i) the number of subclasses should be kept to a minimum that will satisfactorily distinguish lands within a class likely to differ significantly in their management requirements, and/or potential for improvement, due to differing limitations.
NOTE: it is not the purpose of the subclasses merely to provide information on the nature of limitations.

(ii) as few limitations as possible should be used to qualify ("Label") any one subclass.[+)]

Within Order 2 (Conditionally suitable) the suitability subclass would be required to distinguish the nature of the condition(s) under which the land concerned is suited to the particular land utilization type, in addition to the nature of the class-determining limitations. It is proposed that a capital letter immediately following the class symbol should be used to identify the specific qualifying conditions of a particular subclass. The conditions represented by this suffix (e.g. 2.2D) would need to be defined as concisely as possible in the mapping legend and supporting text. Suffixes having a mnemonic significance could usually be chosen for this purpose. For example, the symbol 2.2Dw might represent land with limitations of wetness, yet moderately suitable for the use in question on condition that drainage, not foreseen in the general specifications of the land utilization type, is installed.

Land suitability units would be subdivisions of the subclass; all having similar limitations and the same class-determined suitability but differing[++)] in their production characteristics or in minor aspects of their management requirements (often definable as differences in detail of their limitations). Their recognition

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[+)] One, rarely two lower-case letters should normally suffice. Legends of subclass maps should incorporate a reference to accompanying basic maps or text explaining the exact nature of the limitations.

[++)] add *from each other*

permits detailed interpretation at the farm planning level. It is proposed that suitability units within each subclass be distinguished by an arabic number enclosed in brackets and placed last in the classification symbol (e.g. 1.3w(6) or 1.2t(12)). The sequence in which suitability units are numbered is not significant but, for convenience, would often be arranged in correspondence with their geographical distribution.[1)]

The full range of groupings proposed is summarized in the following table:

CATEGORY	ORDER	CLASS	SUBCLASS	UNIT[+)]
NUMBER OF GROUPINGS	three	unlimited	unlimited	unlimited
GROUPINGS	1. Suitable	1.1	1.2w	1.2w(1)
		1.2	1.2t	1.2w(2)
		etc.	1.2wt	1.2w(3)
			etc.	etc.
	2. Conditionally suitable	2.1	2.1At	
		2.2	2.1Bt	
		etc.	etc.	
	3. Unsuitable	3.1		
		3.2		
		etc.		

Unclassified land: Land of undetermined suitability for the defined use has no place in the classification until such time as its suitability can be determined. Such land will be shown as a blank on maps and in interpretative tables or by the letters NC - not classified.

In practice, a land utilization type which is considered relevant to a survey area may be clearly irrelevant to certain land units within the area. To avoid possible confusion, the letters NR - not relevant - could be used in place of a classification of these particular units.

The letters NR could also be applied to interpretative combinations which are irrelevant in that they are not meaningful. For example, no meaningful classification of the actual suitability of land can be made for a use which cannot be introduced without major land improvement.

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1) An alternative and perhaps preferable system of symbolization would identify the three Orders as S, CS, and N respectively. Identification of class, subclass and unit would be as before but the subclass symbols would be enclosed in brackets instead of those of the unit, thus: S2(t)5; CS2(Hw)2; N1(tw)

+) Land suitability unit

5.2.3 Proposed definitions of interpretative groupings

Of the groupings proposed in Section 5.2.2, only the Land Suitability Orders, since they are fixed in number, can have standard definitions.

The following definitions are proposed for the three Orders:

ORDER 1: Suitable land

Land on which (sustained[1]) use for the defined purpose in the defined manner is expected to yield benefits that will justify required recurrent inputs without unacceptable risk to land resources on the site or in adjacent areas

ORDER 2: Conditionally Suitable land

Land having characteristics which, in general, render it unsuitable for (sustained) use in the defined manner but which, subject to conditions of management which are not specified in the general definition of the use, could be rendered suitable

ORDER 3: Unsuitable land

Land having characteristics which appear to preclude its (sustained) use for the defined purpose in the defined manner or which would create production, upkeep and/or conservation problems, requiring a level of recurrent inputs unacceptable at the time of the interpretation.

These definitions would be applicable to the "Actual Suitability classification". They would also apply to the "Potential Suitability classification" (without amortization of major capital inputs) if necessary major improvements are assumed to have been implemented. For application to the "Potential Suitability classification" (with amortization of major capital inputs), the qualification "recurrent" may be removed from the description of inputs in each definition since both capital and recurrent inputs would be taken into consideration.

In quantitative classifications, Orders would normally be quantified by relation to the classes which they embrace but, if required, appropriate quantitative parameters could replace the subjective concept "yield benefits that will justify required recurrent inputs" in the proposed definitions.

The number of separate Classes, Subclasses and Units is left to the discretion of individual interpreters. Therefore, no standard definitions for these groupings can be proposed. The classes, at least, will require definition in presentation, however, and the following guidelines can be suggested:

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[1] The desirability of qualifying use as *sustained* in this and subsequent definitions is under active debate.

CLASSES OF ORDER 1 (DEGREES OF SUITABILITY)

Classes should be appropriately named to reflect decreasing suitability for the defined use. The class definitions should reflect a corresponding degree of limitation to the defined use with a consequently reduced margin of benefits due to lower production (if appropriate) and/or increasing inputs for production, upkeep and/or conservation.

If, for example, three classes are recognized in Order 1 as recommended, the following names and definitions might be appropriate[1]:

Class 1.1 Highly suitable

Land having no significant limitations to (sustained application of[2]) the defined use, or only minor limitations that will not significantly reduce production levels (or "benefits" as appropriate) and/or will not raise recurrent and minor capital inputs for production and/or conservation above a readily acceptable level.

Class 1.2 Moderately suitable

Land having limitations which in aggregate are moderately severe for (sustained application of) the defined use that will reduce production levels (or "benefits" as appropriate) and/or increase required recurrent and minor capital inputs for production and/or conservation to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class 1.1 land.

Class 1.3 Marginally suitable

Land having limitations which in aggregate are severe for (sustained application of) the defined use and will so reduce production levels (or "benefits" as appropriate) and/or so increase required inputs on production and/or conservation, that this expenditure will only be marginally justified.

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1) A comment received on the preliminary draft suggests that, if possible, the land suitability classes be defined in terms of an economic parameter and further suggests that *the ranges of net income to be generated by foreseeable ("project") facilities* might serve this purpose.

2) See footnote on p.75

CLASSES OF ORDER 2 (DEGREES OF CONDITIONAL SUITABILITY)

Classes of Order 2 are most easily defined in terms of comparable classes of Order 1 since these are equivalent in assessment of suitability, e.g.:

Class 2.1 Conditionally highly suitable

Land having characteristics which, in general, preclude (sustained) economic application of the defined use but which, subject to the special conditions defined at the subclass level, is equivalent in suitability to land of Class 1.1.

Since definitions at the class level of Order 2 lack essential information on the nature of the qualifying conditions, it would usually be more helpful to develop definitions for the subclasses of this Order which should be few in number, e.g.:

Subclass 2.3Ht Conditionally marginally suitable

Land having limitations of topography which, in general, preclude economic use in the manner defined but which could be used for this purpose and would be equivalent in suitability to land of Class 1.3, provided production was limited to a small range of high-value crops requiring intensive methods of production.

CLASSES OF ORDER 3 (DEGREES OF UNSUITABILITY)

If, as recommended, two classes are recognized in Order 3, the following names and definitions might be appropriate:

Class 3.1 Presently unsuitable

Land having limitations which may be surmountable in time but which cannot be corrected with existing knowledge at presently acceptable cost and which are so severe as to preclude successful (sustained) use of the land in the defined manner.

Class 3.2 Unsuitable

Land having limitations which appear so severe as to preclude any possibility of successful (sustained) use of the land in the defined manner.

6. EVALUATION OF REQUIRED INPUTS

6.1 Basic concepts and requirements

It can be assumed that some form of material, management, labour, infrastructural and institutional input having financial implications will be necessary to achieve

any land-use objective. The inputs required may be of a recurrent and/or of a one-time (capital) nature. Where major capital investments are made additional recurrent inputs for operation and maintenance have to be included.

Reliable assessment of input requirements is obviously no less important than assessment of production or other benefits in determining the suitability of land for a given use.

Broad assessment of the general nature and magnitude of the recurrent and capital inputs associated with each apparently desirable form of land use is one of the first steps in a land evaluation study. Carried out in the context of the study area as a whole and weighed against the expected benefits from each land use this assessment serves to determine which separate forms of use are socially and economically relevant and worthy, therefore, of consideration in the land evaluation proper.

Subsequently, the required levels, variations and/or further specifications of these general input needs have to be refined in relation to each relevant land use in the context of individually mapped units of land.

Even if no need for major improvement is foreseen, identification of recurrent input and management requirements serves three closely related purposes:

(i) as an essential component of the "terms of reference" of the evaluation - specification of management assumptions on which the assessment of suitability is based

(ii) as an aid to implementation and extension - providing guidance on management practices appropriate to identified lands (especially in high intensity studies)

(iii) as an essential base for assessing, and in quantitative classifications for calculating, suitability in input/output terms.

Special significance is likely to be attached to the nature and magnitude of required inputs where major change in land is needed to introduce or improve certain forms of use. Evaluations of the potential suitability of land for these uses will be based on the assumption that the initial inputs required to effect change and the recurrent inputs estimated to be necessary to maintain the altered conditions will be adopted. In this context a choice often has to be made between relatively high initial investments combined with low operation and maintenance costs or vice versa. If the costs of such inputs are high or technically complex in nature they may well determine the kind of development organization required and the need for government or international assistance.

It is often difficult to apportion repayment of major expenditure on land improvement to a particular beneficiary, especially at the stage of resource survey. Water control structures, for example, may provide many benefits other than irrigation water and when land is being evaluated for irrigation the design data on such structures may not be sufficiently advanced to provide a reliable estimate of their eventual costs, much less a basis for deciding the way in which these costs will be recovered. In circumstances such as these, it may not be possible to include all, or indeed any, aspects of capital repayment within the suitability evaluation. What is essential is that the user of the evaluation should be informed of the general nature and magnitude of required capital as well as recurrent expenditure and that he should be left in no doubt as to which aspects of capital repayment have been taken into account, if any, in evaluating suitability for a particular use.

6.2 Proposals

The proposals put forward in Sections 4 and 5 concerning the recognition of land utilization types and the structure and concept of suitability classifications meet most of the described requirements of an evaluation of inputs apart from the classification of the inputs themselves. The following paragraphs are intended to substantiate this claim.

6.2.1 Recurrent inputs

Included under this subhead are:

(i) repeated material inputs such as fertilizers, insecticides, seeds[+)] and water applications

(ii) routine practices such as those associated with soil preparation and conservation, or with the control of pests and weeds

(iii) expenses associated with operation and maintenance and/or depreciation of ancillary services, structures, machinery and equipment.

A separate assessment of foreseeable recurrent inputs is required for each mapped land unit for each land utilization type.

The economic significance of recurrent inputs, assessed qualitatively or quantitatively, would be taken into account in evaluating suitability in all of the proposed interpretative classifications. Thus the evaluation of "actual suitabi-

+) suggested: replace *seeds* by *plant material* (seeds, cuttings, other)

lity" would be concerned essentially with the balance between expected benefits and foreseeable expenditure on recurring activities. The same would be true of the evaluation of "potential suitability (without amortization of major capital inputs)", but here the recurrent activities are those expected to be necessary after needed major improvements have been introduced.

Each evaluation would assume that certain recurrent practices and inputs will be adopted. Those which are essential to the validity of the evaluation would be described within the specifications of the land utilization type. Recognition of an additional land utilization type might be necessary if the pursuit of a particular purpose in part of the survey area was seen to involve an important difference in input requirements. Alternatively, especially if the proportion of the survey area affected was small, this departure from the norm of the utilization type could be recognized by classifying the land concerned in the Conditional Suitability Order - suitability conditional upon adoption of revised input specifications.

Relatively minor differences in the nature, application, timing or combination of specified recurrent input requirements would be distinguished by the recognition of separate land suitability units. Management specifications describing the optimum recurrent practices on each unit for each land utilization type would need to be prepared giving special attention to an explicit statement of those requirements that distinguish one unit from the others. Apart from providing a basis for assessing suitability these management specifications would be a valuable guide to development implementation.

6.2.2 Capital inputs

In the proposed approach an important distinction is drawn between the cost of "one-time" activities aimed at effecting major, reasonably permanent improvement, and capital expenditure related to recurrent management such as the purchase of tractors, implements, storage facilities and similar inputs. If the latter were seen to be essential to implementing a particular land utilization type they would be included in the specifications of the type. Their costs, amortized over an appropriate number of years, would be taken into account as if they were a recurrent input in assessing suitability in all the interpretative classifications.

Since the inputs involved in "major improvement" would often be much more expensive and since their cost would often be shared between several beneficiaries, it is proposed that they be assessed separately in terms of "improvement specifications".

Each "potential suitability" classification would be based on the assumption that specified "major improvements" will be effected but only where necessary. Thus, separate "improvement specifications" would be needed for each mapped unit of land or group of mapped units that differ in the nature or degree of required improvements associated with introducing a particular land utilization type. On the other hand, required improvements would relate to specific limitations of the land and would sometimes be the same, or similar, for a number of related utilization types. Under these conditions, a general classification of improvement requirements based on the principal land limitations and economic situation of the survey area would simplify the problems of developing and describing improvement specifications relating to individual land suitability units.

The structure and content of such a classification would need to be adopted to local conditions but the following examples derived from the Manual of Land Classification for Irrigation of the Soil Institute of Iran[1)] show a possible approach applied to surveys at two levels of intensity:

(a) CLASSIFICATION OF IMPROVEMENT REQUIREMENTS SUITED TO LOW INTENSITY (RECONNAISSANCE) SURVEYS

LEVEL	TECHNICAL DIFFICULTY	COST[+)]	EXAMPLE[++)]
"A" LOW	Low, may require some technical advisory services to the landowner	Low, can in general be borne by the landowner	Stone clearing simple land preparation work, simple levelling
"B" MODERATE	Moderate, requires important technical advisory services to the landowner	Moderate, can be borne by the land owner with credit facilities	Simple grading, moderate antierosion work. Widely spaced open drains
"C" HIGH	High, needs to be entrusted to specialists both for planning and execution.	High, requires Government funds or long-term credit to the landowner	Tile drainage, terracing, simple land reclamation work
"D" VERY HIGH	Usually also requires use of special equipment	Very high, requires large Government funds, subsidies might also be required	Complex land reclamation work

1) Tables are derived from the Manual of Land Classification for Irrigation (Second Approximation, January 1970). Compiled and Edited by P.J.Mahler. Publication No.205. Soil Institute of Iran, Teheran

+) Cost *relative to the farmer* can be the defining criterion in widely different circumstances: not *absolute* cost, the significance of which varies with the socio-economic context

++) valid for Iran

(b) RATING OF IMPROVEMENT REQUIREMENTS SUITED TO HIGH INTENSITY (DETAILED AND SEMI-DETAILED) SURVEY

LEVEL	GRADING	ARTIFICIAL DRAINAGE	INITIAL SALT LEACHING	STONE PICKING	OTHERS
LOW	(g)	(d)	(l)	(sp)	(Small Letter)
MODERATE	g	d	I	sp	Small Letter
HIGH	G	D	L	SP	Capital Letter
VERY HIGH	G	D	L	SP	Capital Letter

Note: This second table shows only the method of symbolizing different levels of selected improvement activities developed in Iran. The precise significance of each symbol is defined separately in the Iranian Manual.

A similar approach based, however, on land suitability units can be used to relate alternative improvement specifications (including levels of inputs) to resulting benefits.

The improvement requirements indicated in table (a) under level A ("low") would in general be considered as minor improvement expenditures, whereas those mentioned under levels C and D would always be rated under major improvement expenditures. The level B "moderate" would be rated as minor or major according to the land utilization type and to the social and economic conditions in the area.

Two kinds of potential suitability classification have been proposed. In the first - "without amortization of major capital inputs" - the investment required to effect the assumed major improvements would not be taken into account in evaluating suitability. To avoid creating an unduly favourable impression of potential it would be essential that this kind of classification be accompanied by an indication of the magnitude of required investment for each interpretative unit. The latter could be developed in qualitative or quantitative terms from the investment specifications of each unit.

As its title - "with amortization of major capital inputs" - implies, the second kind of potential suitability classification would take account of amortization costs of assumed major improvements in evaluating suitability. Expected annual benefits would be weighed against the estimated recurrent costs plus the annual amortization costs. If the data available permit this to be done reliably it would provide the user with a more realistic estimate of the relative merits of development alternatives. The user would need to be informed of the criteria on

which the evaluation was based, including the lifetime of the improvements, the discount rate and the specific costs which had been assumed.

7. DIAGNOSTIC PROCEDURES AND CRITERIA

7.1 Basic concepts and requirements

The significance of diagnostic procedures and criteria differs for those who make and for those who use land evaluations. To the interpreter they are the very essence of his work - the plans and bricks with which he constructs. To the user, insofar as they concern him at all, knowledge of such matters allows him to understand better and to check the reliability of the evaluations he is given - by continued analogy, his insurance or guarantee on the interpreter's structure. This point, if accepted, is of two-fold importance in relation to discussions during the Consultation:

(i) the methods eventually agreed upon for selecting and processing diagnostic criteria must not only satisfy the interpreter's needs in determining the suitability of land, but must also provide an objective basis for checking the evaluations

(ii) standards of classification and presentation can be developed for practical testing without necessarily solving all the complexities of diagnosis - complexities from which, in any solution, the user should be shielded.

The concept of land "suitability" is meaningful only in relation to the use of land for a specific purpose and in a defined manner. Differing degrees of suitability depend upon the relationship, actual or anticipated, between benefits (yield of produce and other benefits) and inputs (recurrent and, where necessary, capital) associated with implementation of the specific use. The nature and magnitude of these benefits and inputs in turn depend on the extent to which the characteristics of the land in question meet, or can be made to meet, the specific requirements of the defined use. Therefore, diagnosis of suitability entails on the one hand identification of the specific requirements of each relevant form of use, and on the other identification and rating of the land characteristics which have a significant relationship with these requirements.

Three overlapping procedures for diagnosing input/output relationships can be recognized[1]:

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1) see Nix, H.A. 1968. "The Assessment of Biological Productivity" from: Land Evaluation, ed. by G.A.Stewart, MacMillan, Melbourne, p.77-87

(i) by measurement and observation, directly where possible or indirectly in analogous situations

(ii) by empirical assessment based on correlations between measured yields and relevant factors of land suitability at various levels of conceptual detail[1)]

(iii) by simulation methods using mathematical growth models[+)] based on theoretical growth relationships and relevant land suitability factors at various levels of conceptual detail[1)].

In considering what level of conceptual detail provides the most effective and most convenient diagnostic criteria of suitability it is necessary to take account of the availability of data, feasibility of measurement, and the extent to which the criterion chosen is independent of other factors in its influence on suitability. Another consideration is the extent to which the criteria chosen serve to guide practical management decisions and to identify improvement necessities and possibilities. In this context ratings of the more complex ecological factors such as "availability of water" are more informative than ratings of single land characteristics such as texture.

The recognition of improvement possibilities is an aspect of suitability diagnosis that deserves special emphasis and not only because it is often overlooked. The nature of land largely determines whether a desired improvement, essential for given use, is feasible. Furthermore, examination of land characteristics with the possibility of improvement in mind may lead to recognition of completely new opportunities for rural development requiring study. A large number of land characteristics are likely to influence improvement possibilities. Especially note-

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1) The factors which influence land suitability can be conceived at various levels of detail. *Yield* (produce and/or other benefits), *production inputs* and, where relevant, *improvement inputs* represent the most comprehensive expressions of the factors of land suitability. Each is the resultant of interplay between a number of ecological factors of lesser complexity specific to the land in question. Amongst less complex factors important to plant production one can list, as examples: availability of water, availability of oxygen within the rootzone. Each of these factors, in turn, is determined by the interaction of still less complex single, or minor compound, characteristics of land. For example, the water available for plant growth is determined by the useful precipitation, its distribution in time and its variability, interacting with the accessibility of groundwater, if any, and the total readily available moisture in the soil. The last item reflects the influence of texture, structure, kinds of clay minerals, effective rooting depth and other characteristics of relatively minor complexity.

+) A growth model prepared from an economist's point of view is described by LOCHT (1971, see documentation)

worthy are the agro-ecological factors that influence production capability rather than plant growth itself. These may be important criteria of land suitability. They include such factors as resistance to soil erosion, aptitude for mechanized cultivation, irrigability and drainability.

For a given broad kind of land-use the same group of ecological factors are likely to determine land suitability, even on different kinds of land. Vice-versa, a given tract of land will have many characteristics that in common are relevant to the suitability of many different kinds of land-use, although some factors are relevant only to specific uses. In general, a limited number of factors will provide an adequate basis for the evaluation of a large number of possible kinds of use. The significant levels of each factor,however, are likely to differ for different uses.

Only if the expression of a land characteristic is extreme (e.g. very steep slope, very shallow soil) is it likely to influence suitability independently. Thus, the majority of characteristics must be considered jointly with, or in relation to, other characteristics which modify their significance. The inter-relationship of characteristics is especially important in assessing the possibilities of change in land, whether it be deliberate change (improvement) or otherwise. Change in one characteristic (e.g. slope, drainage) may induce profound changes in many others, possibly in the whole nature of the land.

7.2 Proposals

It is apparent that it will not be possible to discuss all aspects of diagnostic procedure during the Consultation and it is proposed, therefore, that discussion should centre on two aspects:

(i) possible advantages of grouping land characteristics for diagnosis

(ii) the role of economic considerations in giving weight to class-determining criteria.

The aim should be to establish a basis of agreement on procedures which, whilst appropriate for present implementation in most countries, will recognize a need to develop more sophisticated approaches to data processing in the future.

7.2.1 Grouping land characteristics for diagnosis: "major land qualities"

In many existing systems of land evaluation, single or minor compound land characteristics, such as texture or drainage, are used as a basis for diagnosis and for establishing class-determining specifications. Shortcomings of this procedure, as

noted in the previous section, include difficulty in allowing for the interaction between characteristics, in showing how limitations relate to management and improvement requirements, and in extrapolating conclusions to other areas.

It is proposed to discuss, therefore, whether or not it would be advantageous to identify and define combinations of land characteristics relevant to specified uses to be employed in diagnostic procedures.

It is further proposed that such a combination should be called a "land quality" and defined in general terms as follows:

Land quality: A single land quality is a complex attribute of land which, when used as a diagnostic criterion, acts largely independently of[+)] most other land qualities in its influence on the suitability of land for a specific kind of land-use. The expression of each land quality is determined by a set of interacting single (or compound) land characteristics (q.v.) having different weights in different environments depending on the values of all characteristics in the set.

A major land quality may be used as a largely independent[++)] diagnostic criterion reflecting limitations to land suitability. It may be rated and quantified, and suitability class limits specified using the rated criteria. Although, in principle, a large number of land qualities have to be combined to arrive at a satisfactory evaluation, in practice it will usually be necessary to consider only a few for each relevant land utilization type. This is either because other major land qualities are constant throughout the area or because one or a few are so extreme that they dominate all other factors in the assessment of land suitability and improvement capacity. Furthermore, within a specific environment, a very few single, or minor compound, land characteristics may be decisive within the dominant major land qualities, thus providing a basis for relatively simple specifications that will largely determine suitability within the given area.

The following list of major land qualities[+++)] for rural land use is provided, as a first approximation, to give an indication of their intended nature[1)]:

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1) Adapted from Beek and Bennema, 1972 (mimeo)

+) replace *when used as a diagnostic criterion, acts largely independently* by *acts in a manner clearly distinct from the actions*

++) delete *largely independent*

+++) It should be noted that information derived from delineated defined soils constitutes an important part of the data for a number of land qualities

1. Major land qualities related to plant growth

- availability of water
- availability of nutrients
- availability of oxygen for root growth
- availability of foothold for roots
- conditions for germination (seed bed c.a.)
- salinization or alkalinization +)
- soil toxicity or extreme acidity ++)
- pests and diseases related to the land
- flooding hazard
- temperature regime (including incidence of frosts)
- radiation energy +++)
- wind and storm as affecting plant growth
- hail and snow as affecting plant growth
- air humidity as affecting plant growth
- drying periods for ripening of crops and at harvest time

2. Major land qualities specifically related to animal growth

- hardships due to climate
- endemic pests and diseases
- nutritive value of grazing land
- toxicity of grazing land
- resistance to degradation of vegetation
- resistance to soil erosion under grazing conditions
- availability of drinking water
- accessibility of the terrain

3. Major land qualities related to natural product extraction

- presence of valuable wood species
- presence of medicinal plants and/or other vegetation extraction products
- presence of fruits
- presence of game for meat and/or hides
- accessibility of the terrain

4. Major land qualities related to practices in plant production, in animal production or in extractions

- possibilities of mechanization
- resistance towards erosion
- freedom in the layout of a farm plan or a development scheme, including the freedom to select the shape and the size of fields
- trafficability from farm to land
- vegetation cover in terms of favourable or unfavourable effects for cropping

In this list only those major land qualities are shown which relate to agricultural use, if other uses are envisaged (Wildlife and recreation, village areas,

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+) replace by *and/or*

++) added item

+++) and photoperiod

fishing, waste disposal), many similar and some quite different major land qualities will become relevant. Major land qualities related to infrastructural requirements are not listed here but may have to be taken into account also.

Major land qualities related to the requirements of major land improvement works will also have to be listed separately. Some examples are: irrigability, drainability, presence of potential dam sites.

Within each major land quality a number of constituent single, or minor compound, land characteristics would need to be distinguished. No proposals for the specific subdivision of the major land qualities are given here but it is suggested that only those land characteristics which provide essential information for one or more of the following purposes should be specifically recognized:

(i) for rating the major land qualities to which they belong

(ii) for specifying management practices to be used on individual land units or groups of units

(iii) for specifying minor or major improvements to be carried out on individual land units or groups of land units.

An apparent difficulty in the application of the major land quality concept lies in the problems involved in obtaining any direct measure of some of the qualities concerned, either for purposes of evaluation or as a subsequent check upon the accuracy of the evaluation. However, only the general level of many agro-ecological factors reflected by land qualities requires to be known in order to develop a reliable land evaluation. General levels of these qualities can often be assessed by observing existing plant life and farm management practice within the area, or in analogous situations. If an assessment of general level is not sufficient, the status of the land quality will require to be assessed from its constituent properties by the same methods (including parametric methods) presently applied for evaluating land as a whole. Wherever possible, objective standards based on interrelation of mapped basic land resources data, meteorological data, field experiments and/or laboratory investigations should be used for rating the land qualities in relation to individual land utilization types and for establishing class-determining specifications.

Levels of production are, in a sense, "super" qualities of the land in that they reflect, at a given level of input, the integrated effect of all other land qualities. Production levels can be measured experimentally, derived by correlation, or estimated by parametric methods.

It is suggested that an orientative list of the main requirements of envisaged plants, animals and land-use practices be drawn up before the assessment of major land qualities and of single, or minor compound, land characteristics is carried out. This assessment would provide the limiting criteria to be used for distinguishing the subclasses and units proposed in section 5.2.2.

Major land qualities would provide a particularly valid basis for comparing areas between which an exchange of information and experience on production, management practices and input requirements is being considered.

7.2.2 Economic considerations in rating diagnostic criteria

It is proposed that the boundaries of mapped units on which interpretation is based should be determined solely by physical[1)] criteria. This implies, since the interpretative classes will be applied directly to the mapped units, that the class-determining criteria must also be of a purely physical nature, although in each case the physical criteria can, and should, be selected in relation to general economic considerations.

It has also been proposed that interpretation should proceed through a qualitative stage (if necessary) to a quantitative stage at which each suitability grouping would be given a fairly precise economic significance. It is proposed that this be achieved by collecting economic data relating to the land utilization type in question on the mapped units (or on comparable sites) and by drawing up economic balance sheets (cost of production such as cost of seed, herbicides, labour etc., in relation to market return from produce), for each appropriate interpretative grouping for each utilization type.

Since land suitability units, at the lowest level of classification suggested, have a narrow range of qualities it will generally be possible to up-date the suitability ratings when necessary, changing the suitability class and possibly the suitability Order of specific mapped units of land in the light of more precise, or changed, economic data.

A problem related to these procedures which should be discussed during the Consultation relates to the distinction between "suitable" and "unsuitable" land (i.e. between land of Orders 1 and 3). In practice unsuitable land is often clearly distinguished be extreme expressions of physical land characteristics which can be mapped precisely. If, however, suitability is in doubt in areas where physical differences are less pronounced it will be fortuitous whether, at any given mo-

1) as opposed to social or economic

ment, any mapped boundaries reflecting physical differences will precisely separate the economically unsuitable land. The problem is one of precision but it could have practical importance.

The alternative procedure, in which precise economic criteria translated into physical terms are used as a basis for establishing the specifications of suitability classes does not appear to be feasible except perhaps in the most advanced communities.

8. PRINCIPLES OF PRESENTATION

8.1 Basic concepts, requirements and restraints

Maps, with explanatory legends, usually provide the most satisfactory means of conveying land evaluation data to the user. Evaluation data may also be presented in tabular form, especially if the geographic distribution of the land units concerned is not of prime concern (e.g. statistical assessments) or is adequately displayed on existing maps. In either case, a supporting text is almost always required to further define and explain the procedures used and to present the basic data on which the evaluation is based.

The principal restraints which stand in the way of presenting evaluations as exhaustively and effectively as possible relate to cost, to time and to a need for simplicity. Evaluations which are so detailed that the principal findings are obscured, defeat their own ends. Maps, especially coloured maps, are expensive and time-consuming to produce. Some evaluations, because their validity is ephemeral and their circle of interested users small, cannot justify the cost of expensive map production, and rough sketch maps must suffice. Timeliness is often the essence of useful evaluation.

Restraints on presentation should not be permitted to limit the precision with which each evaluation is defined and qualified. Points of explanation of special importance yet commonly omitted from land evaluation texts include:

(a) the precise nature of the land utilization type for which the suitability of the land is judged, including reference to the level of management assumed

(b) the extent to which the evaluation depends upon major change in existing soil and/or other environmental conditions

(c) the precise nature of any assumed inputs

(d) the extent to which the interpretative judgements are based on quantitative rather than qualitative data

(e) if qualitative data have been used: some examples to show the order of magnitude of inputs and outputs.

In considering map presentation, a distinction should be drawn between evaluations intended for broad planning purposes, which are usually based on inventories of large areas at low intensity, and the more detailed evaluations intended to guide implementations of development. The former aim at appreciation of varying land potential in an entire survey area by contrasting the suitability of different land units for alternatives of use. The more detailed studies aim to supply maximum information on the potential and limitations of individual sites in relation to a specific use. Different approaches to the design of map symbols and legends are needed to meet these opposed requirements, as well as the various requirements of different categories of users.

8.2 Proposals

Clearly, until agreement is reached on the substantive aspects of the framework, proposals on presentation are intended merely as examples of how data grouped in the ways suggested could be set out. Participants in the Consultation are invited to supply alternative examples for discussion.

8.2.1 Evaluation maps

It is proposed that a need for both multiple use evaluation and single use evaluation maps should be foreseen.

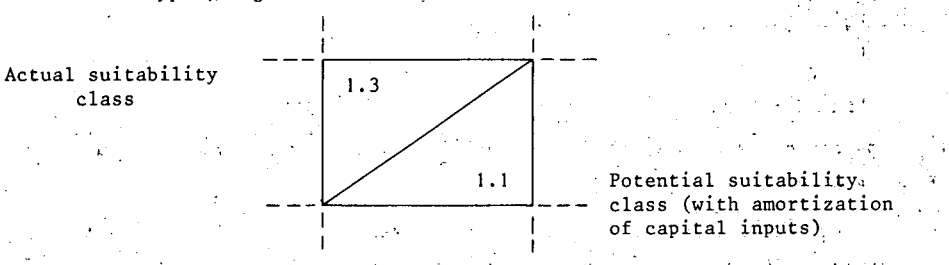
Multiple use evaluation maps would mainly be used to portray interpretations of low intensity inventories for broad planning purposes, but could also provide summaries of evaluation data from more detailed surveys. Map symbols could be simple numbers, serving only to identify each land unit in one or more tabular legends. Each tabular legend would show, in parallel columns, the suitability class of each land unit for each land utilization type and possibly selected differentiae related to the relevant diagnostic criteria. Separate tabular legends could indicate Actual Suitability Classes and Potential Suitability Classes (with or without amortization of major capital investments). In the case of either of the potential suitability classifications, indications of the level of capital inputs should be listed.

The map legend might take the following form:

ACTUAL SUITABILITY CLASSIFICATION

LAND UNITS	LAND UTILIZATION TYPES			
	A	B	C	
1	1.1	1.3	1.2	
2	1.2	2.1H	1.2	
3	1.3	3.1	1.3	
4	1.2			
etc.				

In some cases both Actual and Potential suitability classifications could be combined in a single tabular legend by dividing each "cell" linking land units and utilization types, e.g.:



It is undesirable to present a Potential suitability classification without amortization of capital inputs unless a specification in broad classes of required major improvements is also shown. This can be achieved by dividing each "cell" into three to indicate the classification of required major improvement between the Actual and Potential suitability classifications[1]. This division into three will also clarify relationships in the case of a Potential Suitability Classification "with amortization of capital inputs".

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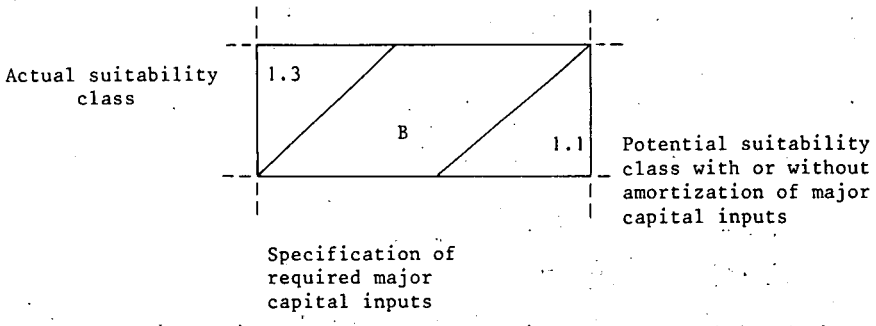
1) Examples of the practical application of these methods of legend construction have been demonstrated by the Soil Institute, Iran, e.g.: "Report on Land Resources and Potentialities of Gorgan Region. Publication No. 197, April 1969."



If only a single kind of evaluation of a single use is being presented the separate mapping units, instead of being numbered, could show either the Actual suitability classification, or the Potential suitability classification plus specification of required major capital inputs.

Note also the system of symbolization recommended in the Manual of the Bureau of Reclamation of the US Department of the Interior, 1951, in which the classification symbol is followed by further symbols defining the nature of the soil and of the site.

8.2.2 Evaluation tables

It is proposed that tables be used extensively to:

(a) present evaluation findings. Tables relating to single land utilization types can conveniently present the suitability classification(s), the management specifications and, if appropriate, the required major capital inputs for each suitability grouping or map unit

(b) summarize the defined characteristics of land utilization types (including management specifications pertinent to each utilization type as a whole)

(c) list relevant physical, social and economic data and the specifications used in each classification. This data should include, if possible, all available information relevant to the comparison of expected productivities and profitabilities as well as required annuities under actual and potential conditions (without and with major capital inputs)

(d) summarize the characteristics of the land units mapped.

8.2.3 Supporting text

It is proposed that texts should be as brief as possible - conceived in a supporting role for maps and tables. A certain minimum of text comprising definition of

classes and terminology and the explanation of basic assumptions, is, however, essential.

NOTE: These comments relate only to the presentation of land evaluation data. In addition, natural resource surveys give rise to basic data of more lasting value which will continue to require adequate permanent record in text and maps.

9. OVERALL APPROACH TO LAND SUITABILITY CLASSIFICATION

9.1 Basic concepts and requirements

Land evaluation, including the choice of the relevant land utilization types, is essentially teamwork, because of the range of data which is relevant as well as the wide range of possible uses of the land. If a team of specialists is constituted at an early stage, the gathering of data can proceed faster and more efficiently than if data on soils, water, land use, economics of crop production and marketing, and other aspects are collected separately. Specification of the degree of detail required in the different surveys and studies by the separate specialists of such a team will also materially reduce the costs, and pinpoint areas of study where concentration of effort is needed.

A first requirement is co-operation between resource surveyors and both social and economic planning specialists to decide the broad directions of possible development. The range of information needed to determine the feasibility of such development and the extent to which this information is already available should then be established. Only then can the nature, intensity and scope of required surveys and studies be decided. Often much duplication of effort can be avoided by an early and thorough search for data in the wide variety of data gathering organizations. Since, of necessity, agronomic experiments and the collection of yield data take a number of seasons, any field experimentation required to supply data for management planning and economic analysis should be initiated as soon as possible. A minimum of information on climate, hydrology and soils, preferably from sample areas, is needed first, however, to permit identification of representative experimental sites. At the same time, the need, if any, for additional meteorological or hydrological stations should be determined.[+)]

[+)] To avoid delays in decision-making, provisional evaluations should be produced using reasonable, explicit assumptions where full data are not yet available. Interpretations should be in a form allowing incorporation of such new data. Provisional evaluations may be made starting from soils and agronomy; engineering; or economics and sociology.

Jointly with the specification of natural resource studies, the team should establish what further social, economic and institutional data are needed for the several stages of land evaluation. These can be identified and defined on the basis of information on present land use, supplemented with socio-economic data and with knowledge and experience from comparable areas. Experience in comparable areas sometimes forms the main source of available data. To be reliable, such comparison must be based on systematic correlation of environmental data, including soil classification.[+)]

Continuing contact between all team members needs to be maintained throughout the work not only to ensure timely and efficient collection of all necessary information, but also to avoid superfluous detail or irrelevant studies.

The surveys and studies should yield a map, or maps, which show an integration of the distribution of basic land characteristics to serve as a basis for land suitability evaluation. Of the different resource surveys (climate, vegetation and land use, soil and landform, geology and hydrology) it is often the soil survey which yields the map most significantly differentiated in relation to possibilities of land use. In this case the soil map, with other resource data such as climate and hydrology superimposed upon it, can serve as a base for the delineation of adequately defined land units.[++)] In other circumstances, the vegetation or hydrology maps may provide the most suitable base for the integrated map of land.

A draft classification of the suitability of each unit of land for each of the identified land utilization types should be prepared as soon as possible so that any additional data seen to be needed can still be obtained before the field studies are completed. Although such a draft classification need not be expressed in quantitative terms, it should take into consideration quantitative data available from agronomic experiments and other sources. In evaluating each land unit[++)], particular attention should be given to ensuring that within the unit management and improvement requirements relating to the defined use are sufficiently uniform as to permit a detail of interpretation commensurate with the purpose and intensity of the survey and to serve as a base for subsequent quantitative studies and economic analysis. At the same time the proposed criteria for defining the alternatives of use and for assessing the suitability of land for these uses should be critically examined to ensure that they, too, are appropri-

+) See footnote on p.94

++) Read *land mapping units* (may be based upon soil series, associations, land systems or others as appropriate)

ate to the purpose and intensity of the survey. One of the resource surveyors is often responsible for preparing the first draft of the suitability classification, but the proposals should be examined by the other specialists in the team and should be shown to economic planners and other potential users so that they may have the opportunity to specify any further requirements at this stage.

A field check of the final[+)] land evaluation is essential to ensure that separate aspects of the environment have been validly integrated and interpreted. The intensity of checking can be relatively low if close integration of surveys and studies during the field work has automatically provided reliable cross-checks on the collected information.

Towards the end of the surveys, it should be possible to develop the land suitability classifications in quantitative terms, as a basis for comparing different use possibilities on specific areas of land and for discarding those which are clearly less attractive. Thus, this final[+)] stage of land evaluation, best carried out jointly by soil scientists, agronomists[++)] and economists, serves to identify the most promising possibilities for development or rural readjustment and other objects mentioned in paragraph 1.1. More elaborate socio-economic analysis of these promising possibilities will then be justified as the next stage in the planning process.

9.2 Proposals

On the basis of the proposals put forward in previous sections, the following overall procedure for land evaluation, step-by-step, may be suggested:

(i) Formulation of the[+++)] purpose and scope of the land evaluation

(ii) Preliminary assessment of relevant land utilization types to establish the major diagnostic criteria (land qualities) which will require to be investigated in land evaluation and thus to determine the required intensity and scope of basic surveys. This assessment is based upon the overall socio-economic and physical conditions of the area which may first require to be broadly investigated

(iii) Basic inventory of land resources by surveys of landform, geology, soils, present land use and vegetation; by hydrologic and climatic studies; and/or by other investigations, where applicable, leading to the identification and delineation of adequately characterized land units ++++)

+) delete *final*

++) add *irrigation engineers where relevant*

+++) replace *Formulation of the* by *Identification of present land use problems. Formulation of the basic assumptions*

++++) read *land mapping units*

(iv) Collection of quantitative data relating to each characterized land unit +) (e.g. production levels, recurrent costs and other socio-economic data). Initiation of experimentation where needed to generate further data and develop improvement specifications

(v) Decision on the apparently most promising land utilization types for which separate systematic interpretation is required, and precise definition of these land utilization types including the means for their attainment

(vi) Establishment of specifications for diagnostic criteria (land qualities) that will define interpretative class levels for each land utilization type

NOTE: Steps (iv), (v) and (vi) should overlap step (iii) to ensure that intensity of survey and data being collected is appropriate

(vii) Qualitative actual suitability evaluation of each land unit[+)] for each land utilization type by a comparison of characteristics (qualities) with the specifications established at step (vi)

(viii) Detailed interpretation of management and minor improvement specifications for each land suitability grouping for each land utilization type

(ix) Identification, appraisal and classification of desirable major improvements (major capital ++) inputs), if any, that would create new or improved land-use possibilities

(x) Qualitative evaluation of potential suitability (without and with amortization of major capital ++) inputs) of each land unit for each utilization type based on estimates of changed diagnostic characteristics (qualities) due to implementation of major improvements, of recurrent costs for operation and maintenance, and of the level of major capital ++) inputs

(xi) Reconsideration, where necessary, of management and minor improvement specifications for each land unit +) for each relevant land utilization type under conditions following major improvements

(xii) Field check on accuracy and consistency of suitability and input appraisals +++)

(xiii) Conversion of qualitative present and potential suitability evaluations into the corresponding quantitative evaluations when the necessary socio-economic and production data become available or can be reliably estimated.

NOTE: It is assumed that such socio-economic investigations as fall within the scope of an integrated survey of natural resources, will have proceeded in parallel with the land evaluation activities described.

+) read *land mapping unit*

++) replace *capital* by *non-recurrent* (since inputs may be largely of labour with a very low opportunity cost, for example). Some speakers advocated *significant* instead of *major* improvements

+++) add *also considering the relevance of the land utilization types considered*

10. GLOSSARY

Agriculture: Used in this document in a broad sense embracing all aspects of plant and animal husbandry for production, conservation or aesthetic purposes and thus including forestry, cattle breeding, horticulture, etc.

Diagnostic criterion: an environmental variable, or set of variables, having an understood influence upon the output and/or the required input of a specified land use which can be used, where relevant, as a basis for assessing the suitability of a given tract of land for that use.

Ecology: the interrelationships between organisms and their environments.

Ecological factor: a variable attribute of an organism or of its environment that affects the interrelationship between the two.

Agro-ecological factor: an ecological factor (q.v.) having specific relevance to the field of agriculture.

Land: "A tract of land is defined geographically as a specific area of the earth's surface: its characteristics embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area including those of the atmosphere, the soil and underlying geology, the hydrology, the plant and animal populations and the results of past and present human activity, to the extent that these attributes exert a significant influence on present and future uses of the land by man" (see also Section 4.2.1).[+)]

Land characteristic: attribute of land that can be measured or estimated.

Land evaluation: the process of collating and interpreting basic inventories of soil, vegetation, climate and other aspects of land (q.v.) in order to identify and make a first comparison of promising land-use alternatives in simple socio-economic terms (see also Section 2).

Land quality:[++)] a land quality is a complex attribute of land which acts in a manner clearly distinct from the actions of most other land qualities in its influence on the suitability of land for a specific kind of land use. The expression of each land quality is determined by a set of interacting single (or compound) land characteristics (q.v.) having different weights in different environments depending upon the values of all characteristics in the set. A land quality may be used as a diagnostic criterion (q.v.).

[+)] similar concepts *ecosystem* and *agro-ecosystem* discussed in Session II, p.14

[++)] modified (cf. Section 7.2.1, p.85 and Session IV, p.23)

Land suitability: the fitness of a given tract of land for a defined use. Differences in the degree of suitability are determined by the relationship, actual or anticipated, between benefits and required inputs associated with the use on the tract in question.

Land suitability classification: an appraisal and grouping (or the process of appraisal and grouping), of specific tracts in terms of their relative land suitability (q.v.) for a defined use.
Three kinds of land suitability classification are recognized:

Actual land suitability classification: relates the suitability of land units for the use in question in their present condition - i.e. without major improvements (q.v.) - suitability being assessed in terms of expected benefits in relation to required recurrent and minor capital expenditure

Potential land suitability classification (without amortization of major capital inputs): relates the suitability of land units for the use in question at some future date after major improvements (q.v.) have been effected where necessary, suitability being assessed in terms of expected future benefits in relation to future recurrent and minor capital expenditure but excluding consideration of repayment costs on major capital expenditure

Potential land suitability classification (with amortization of major capital inputs): the same as above but including consideration of repayment costs on identified aspects of major capital expenditure.

Each of these classifications may be expressed in either qualitative or quantitative terms (q.v.) (see also Section 5.2.1).

Four categories of land suitability are recognized:

Land suitability order: the highest category of generalization in the land suitability classification (q.v.). All kinds of land are divided into three orders of suitability - suitable land; conditionally suitable land; unsuitable land (defined in Section 5.2.2).

Land suitability class: a sub-division of the land suitability order (q.v.) serving to distinguish tracts which differ in degree of land suitability (q.v.) (see also Section 5.2.2).

Land suitability sub-class: a sub-division of the land suitability class (q.v.) serving to distinguish land having the same degree of land suitability (q.v.) but differing in the nature of the class-determining limitations and, for conditionally suitable land (Order 2), in the class-determining conditions of use.

Land suitability unit: a sub-division of the land suitability subclass (q.v.) that serves to distinguish tracts belonging to the same subclass but differing in their management or improvement requirements.

Land utilization type: a specific sub-division of a major kind of land use (q.v.) serving as the subject of land evaluation and defined as precisely as is practical, in terms of nature of produce, level of management, capital input etc. (see also Section 4.2.2).

Limitation: expression of a diagnostic criterion which adversely affects a specific land utilization type.

Major improvement: a substantial capital, as opposed to recurrent investment[+)] in land improvement which can rarely be financed[++)] by the individual farmer and which will effect a very significant and reasonably permanent (i.e. lasting in excess of about ten years) change in the characteristics of the land (see also Section 5.2.1).

Major kind of land use: one of the few different major alternatives of land use such as forestry, grassland, irrigation agriculture, rain-fed agriculture, recreation, etc.

Minor improvements: improvements to the land which can be financed by the individual farmer from his current income or with short term loans and which, in general, effect no long lasting change.

Produce: the product or group of products or benefits resulting from the application of a specified land utilization type (q.v.) to a specific tract of land.

Production level: the amount of produce (q.v.) in physical or monetary terms that can be derived from a unit of land in a standard period of time under a specified land utilization type (q.v.)

[+)] replace *capital, as opposed to recurrent investment* by *non-recurrent input*

[++)] add *or executed*

Qualitative and quantitative land suitability classifications: a land suitability classification is only described as quantitative if the distinctions between the interpretative groupings are defined in numerical economic terms which permit objective comparison with similarly defined groupings relating to other utilization types.

Soil: a three-dimensional body occupying the uppermost part of the earth's crust and having properties differing from the underlying rock material as a result of interactions between climate, living organisms (including human activity), parent material and relief over periods of time and which is distinguished from other "soils" in terms of difference in internal characteristics and/or in terms of the gradient, slope-complexity, micro-topography, stoniness and rockiness of its surface (see also Section 4.2.1).

Soil suitability:+) physical suitability of soil and climate for production of a specific crop or group or sequence of crops, or for other defined uses or benefits, within a specified socio-economic context but not considering economic factors specific to areas of land. Parallels used in different countries are "land capability" and "vocation du sol".

+) added term and definition

THE MEETING

PROCEDURE OF TECHNICAL DISCUSSIONS

The technical discussions were conducted in a series of sessions, dealing with different aspects of the Background Document. A short introduction was given on each aspect, and was followed by a general discussion of the topic amongst participants.

AGENDA OF THE MEETING	Introducing speaker	Chair
Opening of the Consultation and address of welcome on behalf of the Director General of FAO, Agenda, etc.		R.Dudal
Technical discussions in sessions:		
I. Aims and scope of the Consultation	A.P.A.Vink	J.Bennema
II. The concept of land	T.Eren	V.A.Kovda
III. Land utilization types, concept and proposals	K.J.Beek	V.A.Kovda
IV. Diagnostic criteria and inputs	J.Bennema	J.Carvalho Cardoso
V. Specific aspects of land to be investigated in basic surveys: discussion on Checklist	J.L.Unger	J.Carvalho Cardoso
VI. Required interpretative classifications	A.J.Pecrot	W.M.Johnson
VII. Interpretative categories and groupings	A.J.Smyth	W.M.Johnson
VIII. Environmental considerations		J.Bennema
IX. The overall approach to land evaluation	K.J.Beek	R.Glentworth
X. Presentation of land evaluation data	J.S.Veenenbos	R.Glentworth
Summation of recommendations		J.Bennema
Closing address by the Rector of the Agriculture University		

OPENING ADDRESS

Dr R.Dudal speaking on behalf of the Director General of the Food and Agriculture Organization welcomed participants to the Consultation. The excellent response to the Director General's invitations reflected, he said, the widespread appreciation of the importance of the topic to be discussed and ensured that the participation was representative of experience gained in many parts of the world and of a wide variety of scientific skills.

Paying warm tribute to each of the Dutch Organizations involved in the arrangements for the discussions and for the excursions, Dr Dudal stressed that from its inception the Consultation had been a joint initiative between FAO and The Netherlands. He referred to the meeting in Rome in October 1970 at which staff of the International Institute of Land Reclamation and Improvement and of FAO had first planned the Consultation; to the cooperation between the two multi-disciplinary committees in preparing the Background Document; and to the strong support, financial and otherwise, received from the University of Agriculture, Wageningen. The presence at the Opening Ceremony of Professor Leniger, Rector of the Agriculture University, was a much appreciated reflection of this support.

Dr Dudal went on to describe what he called the fundamental aspects of the proposals in the Background Document emphasizing in particular that a framework, not a system of evaluation was being proposed. Agreement upon international standards of procedure and terminology was important not only to FAO but also he believed, to other organizations engaged in work in many countries and, indeed, to anyone who was concerned with communicating, or using, information on land resources.

In conclusion, Dr Dudal expressed his belief that FAO had an important role to fulfil in encouraging international communication in all fields of agricultural development but especially in fields, such as land evaluation, which have a direct bearing on the wise use of global resources. FAO was looking forward to receiving the advice of the Consultation on how best to proceed in this field and he wished the participants every success in their deliberations.

On behalf of the Director General of UNESCO, Dr I.Lange thanked the organizers for inviting the participation of UNESCO since rational utilization of land resources was close to the core of many of UNESCO's programmes in environmental science. He referred to some of UNESCO's activities in related fields and in particular to the Man and Biosphere programme. Whilst problems of land evaluation relating specifically to rural development were more closely the concern of FAO, these problems also had a general significance of interest to UNESCO. In wishing the Consultation success he expressed sincere belief that its results would be a valuable contribution to the activities of the United Nations.

FIELD EXCURSIONS

Two days during the Consultation were devoted to a study of practical aspects of land evaluation and development planning in The Netherlands.

The participants spent October 10 in two areas of the Dutch river plains, guided by officers of the Government Service for Land and Water Development (CD,Utrecht). Mr.Westerhof led the morning excursion in the Tielerwaard, a completed land reallocation project, and Mr.Segers the afternoon tour through the Lopikerwaard, where basic surveys and plans for reallocation were shown. Professor Bijkerk of the Institute for Land and Water Management (ICW, Wageningen) gave a general introduction on the background and methods of land planning for rural reallocation at the start of the afternoon programme.

The morning of October 11 was spent in the IJsselmeer polders, where Mr.Smits and co-workers of the Government Service for the IJsselmeer Polders (RIJP, Lelystad) showed the participants a sequence of sites from "raw", newly empoldered lake bottom land to completely developed agricultural land. Different factors with a major influence on land use and land suitability were also illustrated: fresh water seepage, soil texture, soil pattern and major improvements (subsurface irrigation in sandy soils).

The afternoon of the eleventh, Mr.de Bakker and Mr.Pape of the Soil Survey Institute (STIBOKA, Wageningen) explained the changes in land use and land suitability during the last centuries in the margin of the long-settled coversand area east of the IJssel lake and the new polders.

CLOSING ADDRESS

Professor H.A.Leniger, Rector of the University of Agriculture, officially closed the meeting at a buffet dinner given by the University. Professor Leniger noted that the Consultation, a result of an initiative of two committees in FAO and in The Netherlands, was the first international conference on land evaluation, and expressed wonder that such a meeting did not take place earlier. Professor Leniger hoped that the Consultation had been a success and that there would be a follow-up to this joint venture of FAO and the University.

Professor Leniger's own discipline, food science, was rather far removed, he stated, from land evaluation. Still there were some interesting points of contact.

In the first place, planning the development of the food industry raises many questions, of which land suitability is among the most important. Once the land suitability, socio-economic factors, etc. are known, the question of optimization arises: Which materials can be best produced for home consumption and for export, if possible, and which products would better be imported? These problems still have no adequate solution. The reason might well be that there are so many unknowns. Cooperation of experts from a variety of disciplines is needed to solve such multi-disciplinary problems. It might be possible to devote a conference to the methods in which knowledge in various fields can be better integrated in order to arrive at an optimum land use.

A second point made by professor Leniger was that some agronomists tend to forget an aspect of produce central to the food scientist: not only the yield, the cost price, etc. are important, but also the quality of the raw materials. The food industry needs a large and regular supply of produce of a constant and high quality. If this combination of factors is lacking, one cannot produce a regular flow of foodstuffs which meet the price and quality requirements of the world market.

A third point raised by professor Leniger concerned an analogy which may exist between the quality of land and the quality of foodstuffs. The quality of food may be defined as a function of many factors such as appearance, taste, flavor, nutritional value, etc. The interesting point is that the weight of every factor varies from product to product. For example, in one product the nutritional value is very important while in another the colour may be a prime factor. Moreover, the appreciation for a certain quality factor and for the total quality of an article varies from individual to individual, from group to group, from region to region and from country to country, whilst the appreciation also changes in the course of time. This is a very complicated relation, affected strongly by histo-

rical developments, tradition, socio-economical circumstances, etc. Professor Leniger wondered if the quality of land was not also made up of many factors each putting a different weight into the scale. If so, the Conference was working on a very interesting problem, the solution of which would require an extensive study and co-operation of specialists from different disciplines.

Professor Leniger closed by expressing the hope that the Consultation had made a good start with this important study and that there would be a follow-up in the near future.

EXPRESSION OF THANKS

The Consultation

- considering that its deliberations had provided a most valuable international exchange of scientific knowledge and opinion in exceptionally pleasant surroundings

- requested that the record of these deliberations should include this expression of thanks from all participants

- to the Director General of the Food and Agriculture Organization for convening the Consultation

- to the Board of the University of Agriculture, Wageningen, to the Director and staff of the International Agricultural Centre, Wageningen and to International Land Development Consultants, Ltd., Arnhem, for the outstanding facilities and hospitality which they had provided.

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DOCUMENTATION

Papers appended to the Background Document as used at the Consultation

Interpretative land classification in English-speaking countries
(based on material prepared by G.W.Olson). 25 pp.

Interpretative land classification in French-speaking countries
(based on material prepared by J.Boyer). 8 pp.

Land evaluation and classification in East-European countries
(prepared by D.Teaci and M.Burt). 12 pp.

A summary of parametric methods of soil and land evaluation
(prepared by J.Riquier). 7 pp.

Land evaluation for agricultural land use planning - an ecological method
(prepared by K.J.Beek and J.Bennema). 16 pp.

Multi-purpose land evaluation in Iran
(based on a paper prepared by M.Vakilian and P.J.Mahler). 6 pp.

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